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VOL. XIV, NO. 1 JANUARY, 1932 Old Series Vol. XXX, NO. 1

The Journal of Bone and Joint Surgery

THE MECHANICS OF MUSCULAR CONTRACTURES IN WRIST AND FINGERS*

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The objective of this study is to show that muscular contractures are subordinated to biophysical laws. The selection of wrist and finger contractures to demonstrate the operation of these laws is a mere matter of expediency. It is not to be inferred that, in contractures, the other structures of the locomotor system—the bones, joints, and ligaments—are not similarly dependent upon physical factors. But, in muscular contracture or contracture in the stricter sense, we can define and formulate certain dynamic and static influences operative in producing the pathological situation. It is this biophysical analysis which makes for a better grasp of the inherent nature of contracture.

In order to make a discussion of this kind worth while two things must be shown: first, that our clinical conception of muscular contractures is inadequate for the understanding of its nature; and, second, that the mechanical analysis adds something definite which is not only of theoretical interest, but also of practical use. First of all, contracture is not a haphazard event; it has regularity and consistency which indicates that it follows physical laws. If it is possible to ascertain, by measurement and trial, the physical properties of the muscles under normal and pathological conditions, one should be able to substitute the definite values obtained in the general formula by which the laws find their mathematical expression. Unfortunately, the physiological fluctuations make it next to impossible to set up the same standard numerical values of such factors as elasticity, viscosity, and contractile power, as one can obtain from inert homogenous material. On the other hand, we are not so much concerned with absolute values as we are with establishing relations between the physical properties of the muscles in specific situations and their visible locomotor effect.

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Looking at the mechanical complex of contracture as a whole, we may expect to obtain three types of data from clinical and experimental observations: first, there is the mechanical situation in a stricter sense, which comprises the anatomic arrangement and the external influences under which the muscles work; secondly, there is the innervational factor which determines the states of tension and relaxation of the muscle; and, third, there are the intrinsic physical properties of the muscle tissue itself. Physiologists interested in locomotion have studied the physiological aspect of the problem from all three points of view; on the pathological side, however, our knowledge is still meager and inadequate.

The relationship of all three types of physical factors and the development of myogenetic contractures can be cited as follows:

1. Myogenetic contractures may be the result of a pure muscle imbalance on the basis of a defect or loss of part of the muscular apparatus surrounding the articulation. This implies a redistribution of the muscle power and a new pathological equilibrium. To this, the remaining muscle material becomes adapted by a gradual change in its anatomical make-up. The normal, neutral state of balance obtaining under physiological conditions must yield to a new, pathological one. It is in this group that the external factors leading to contractures may be studied most advantageously, since all primary intrinsic muscle changes are absent. Infantile, obstetrical, and peripheral paralysis belong to this group.

2. A redistribution of the normal muscle power is created, not because of defect or loss of certain portions, but by virtue of the uneven distribution of the innervational impulses. This group is represented by spastic paralysis. The fact that weakness or paresis of certain muscle groups may coexist does not make any essential difference because the first and foremost factor is a loss of cerebral inhibition of subcortical and reflex stimuli.

This group is more difficult to analyze because it is impossible to ascertain quantitative values of innervational impulses and because of the utmost instability of the pathological equilibrium.

3. In the third group, the pathological histomechanics play the deciding part. They entail changes in the intrinsic properties of the muscle,—changes in elasticity, ductility, and viscosity. Pathologically, these are characterized by the degenerative and myositic processes, followed by shrinkage and induration. From the mechanical point of view, the analysis of this type of contracture is still more difficult because we are unable to evaluate in exact terms the changes of intrinsic properties of the muscle tissue, except by loose comparison with the values known for the normal muscle.

We have, then, three types of data to consider: the extrinsic mechanical, the innervational, and the histomechanical.

I. THE PARALYTIC CONTRACTURES

The increasing elastic tension of the antagonist and the decreasing elastic tension of the contracting agonist determine the neutral point of equilibrium.

Let us first consider the simplest situation,—the paralysis of the extensors of the wrist. Normally, the neutral position is twelve degrees' dorsiflexion and three degrees' ulnar abduction. In this position, all requirements for balance are met; all rotation moments of ulnar and radial abduction, as well as of flexion and extension of the wrist, sum up to zero.

What factors determine the new equilibrium?

Passively, there is the elastic tension of the paralyzed extensors of the wrist. A glance at the so called length tension field of the non-innervated muscle teaches us that the resistance of a muscle to passive stretching under a load increases rapidly, and the rate of increase is given by a hyperbolic curve. This is in contrast to the innervated muscle in which resistance to tension increases in arithmetical proportion to the load. This point is of importance for the pathological position because we must expect comparatively early check of contracture.

Another factor is the shortening ability of the active muscle. Physiology teaches us that, with increasing contraction, tension in the muscle decreases rapidly. Therefore, for this reason also, a neutral level must be found, in a position not too extreme, where the increasing elasticity resistance of the extensors and the decreasing tension of the contracting flexors neutralize each other. In time, the flexor muscle will adapt itself to its new position by becoming structurally shortened. It is no longer able to control more than the contraction range, even if the contracture were released. Through its new excursion range it can sweep with perfect ease and normal display of strength, but it cannot go beyond this range because of the adaptive shortening of the muscle fibers. In the normal, the maximum length of the distended fiber is one and six-tenths times and the minimum length of the contracted fiber is twenty-five-hundredths times the natural (resting) length of the muscle. The range between these extremes is one and thirty-five-hundredths times the natural length. Within this range, all motor events occur. The ratio between this difference of extremes to the natural length is the index for the amount of excursion which the muscle can cover. The greater this difference (L max. $-$ L min.) in respect to the muscle length (L), the greater the amplitude. Conversely, the greater the length of the resting fiber (L) compared with the difference between the extremes $\frac{L}{L\ max. - L\ min.}$, the greater is the power which it can display in the terminal positions. This reciprocal $\frac{L}{L\ max. - L\ min.}$ is, therefore, the index for efficiency. In contracture the difference between extremes is smaller, since the muscle can contract or stretch but little; consequently, the remaining amplitude is small. Conversely, because of the smallness of amplitude, the efficiency $\frac{L}{La - Li}$ within its narrow range is comparatively greater. So we find the muscle fully adapted to the new situation; the process of adaptation is even carried to the point of conforming the joint

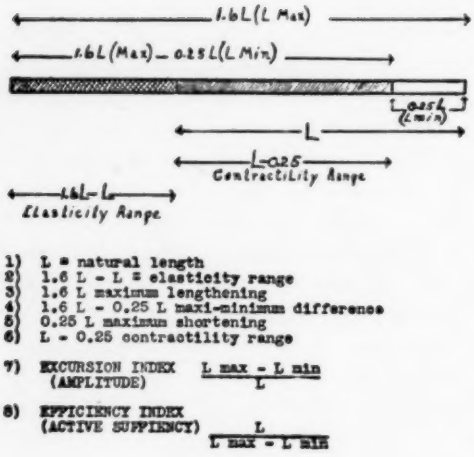
1.6L (L Max)
1.6L (Max) - 0.25L (L Min)
0.25L (L min)
L
L-025
Contractility Range
1.6L - L
Elasticity Range
1) L = natural length
2) 1.6 L - L = elasticity range
3) 1.6 L maximum lengthening
4) 1.6 L - 0.25 L maxi-minimum difference
5) 0.25 L maximum shortening
6) L - 0.25 contractility range
7) EXCURSION INDEX (AMPLITUDE) L max - L min / L
8) EFFICIENCY INDEX (ACTIVE SUFFIENCY) L / L max - L min

FIG. 1

Relation of natural length, contractility range, and elasticity range to excursion and efficiency index.

constituents to the new mechanical arrangement. In this way a new and harmonic mechanical unit, complete and rational in itself, is created. Any discrepancy between too short a casual muscle length and too great an amplitude of motion makes the muscle actively insufficient. It can no longer display power or tension in positions beyond those for which it is fitted by virtue of its natural or assumed length (Fig. 1).

The flexor muscles of the wrist are comparatively short-fibered muscles. Their total shortening varies from three and five-tenths centimeters for the flexor carpi radialis to four and four-tenths centimeters for the flexor carpi ulnaris. On the other hand, their rotation moment in respect to the wrist joint is great. The rotation moment for flexor carpi ulnaris, flexor carpi radialis, palmaris longus, and abductor pollicis longus (also a flexor of the wrist joint) amounts to seventeen and fifty-seven-hundredths centimeter-kilograms, according to Recklinghausen's computations. By contrast, the flexors of the fingers have a much lesser rotation moment, in respect to the wrist joint, and they do not control the terminal ranges of the articulation. Such an arrangement is very similar to that which exists between the rectus femoris and the vasti for the extension of the knee joint, the gastrocnemius and soleus for the plantar flexion of the foot, and the biceps and brachialis anticus in the flexion of the elbow.

It would seem that contracture of the wrist flexors should make for extreme flexion position. But, in purely deficiency contractures, we see that no extreme flexion position develops as it does in the spastic condition. This, again, is due to the antagonistic, passive resistance of the extensors, which increases as the flexion progresses. On the other hand, the same increasing passive resistance, or passive insufficiency, of the extensors produces hyperextension of the metacarpophalangeal articulations because the latter are more forcefully controlled by the finger extensors, due to their greater lever arm. Only by full cooperation of the lumbricales and interossei, which are the antagonists to the extensors in the metacarpophalangeal joint, can the formation of the claw hand be prevented. Indeed, in the paralytic with flexion contracture of the wrist, we see as a second step a tendency to claw-hand formation.

Paresis of the flexors of the fingers accentuates this claw-hand tendency because the finger flexors no longer assist in flexing the metacarpophalangeal articulations.

Of the greatest moment in paralytic disequilibrium is the loss of the intrinsic muscles of the hand. They are the true regulators of balance; they guard the normal equilibrium between long flexors and long extensors by neutralizing the dominating extensory effect of the long-finger extensors upon the metacarpophalangeal articulation, and by antagonizing the long-finger flexors in the phalangeal joints.

The Constitutional Propensity to Contracture. The Common Fields of Tension and Relaxation

In the strictest sense, it is inaccurate to speak of a definite point of joint position at which action between agonist and antagonist alternates. More often, the agonist has already finished its contraction before the antagonist has attained its whole relaxed length. Both muscles are, for a short space, simultaneously under tension. This space is called the common tension field. Less frequently, the antagonist reaches its relaxation for a space of excursion before the agonist has begun to contract; this space is called the common field of relaxation. Practically, it means that, in the first case, the muscles are fitted firmly to the joint, and motion is controlled; in the second case, the muscles are fitted loosely, under slack, and motion is free and limber. In the first case, the muscles are hypersufficient,—the amplitude is too small; in the second case, they are insufficient,—their amplitude is too large.

An instance of a common field of tension is the pairing of the tibialis anticus with the tendo achillis muscles. Here the common field of tension occupies no less than one-fifth of the entire range of motion. The flexors and extensors of the wrist are another instance. Here the common field of tension occupies only one-twelfth of the total amplitude. We notice that both joints require a great deal of stability. An example of the common

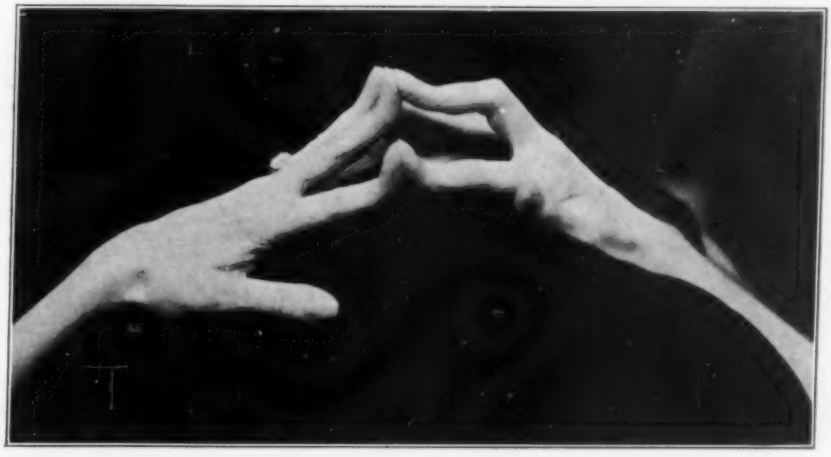

FIG. 2

Common field of relaxation between extensors and flexors. Loose fingers, constitutional.

neutral point is the pairing of the tibialis posticus with the peroneus longus.

Illustrative of a common field of relaxation are the long extensors and flexors of the fingers; here easy mobility is the principal requirement (Fig. 2). This point is of great significance for the mechanogenesis of contractures, particularly those involving the fingers. It can easily be seen that such a state of relaxation may exist as the result of atrophy, or as a natural constitutional condition. Any peripheral resistance directed toward the fingers may modify the type of contracture. We observe this not so much in paralytic as in arthritic contractures where the inflammatory atrophy adds to the relaxation.

To return to the quoted symbolic expression of the amplitude (range) and efficiency indices, it may be stated that the greater the natural length of the fiber compared to the maximum-minimum difference, the greater is the amplitude, the looser is the joint, and the smaller is its efficiency. If this quotient $\frac{L}{L\ max. - L\ min.}$ reaches the point of one and thirty-five-hundredths we speak of a common field of relaxation. When, on the other hand, the tension fields of the agonists and antagonists overlap and the muscles thereby become hypersufficient, the ratio goes below one and two-tenths. In some instances it is as low as six-tenths—in the muscles of the

FIG. 3

Extreme wrist flexion contracture of the spastic.

elbow or of the wrist, for example. In very firm-jointed individuals the coefficient may sink to thirty-four-hundredths.

II. INNERVATIONAL CONTRACTURES. SPASTIC CONTRACTURES

The introduction of the innervational element in spastic cases, either alone or in addition to actual elimination of muscle power, changes materially some of the inherent properties of the muscles. The situation becomes different enough to require special investigation of the physiomechanical premises. Aside from the intrinsic factors of subcortical dominance and lack of reflex inhibition, posture and gravity also are of considerable consequence in this type of upper extremity contractures.

The most important point in regard to spastic contractures is that the resistance of the contracted muscles is greatest in terminal position when insertion and origin are most approximated. Once this resistance is overcome, the spastic contracture yields more easily. Here is a definite contrast to the shrinkage contractures. In these, the resistance of the muscles increases with the amount of stretching, in accordance with Hook's law of elasticity.

Another point in which the spastic contracture differs from paralytic imbalance is that, owing to the enormous surcharge of innervational impulse, the contractile tone is far in excess of the normal maximum contraction. It is of tetanic type. Therefore, we frequently see extreme positions,—as in the flexion contracture of the wrist or in the pronation contracture of the forearm (Fig. 3).

A third point is the lability of the contracture position. When the first resistance is overcome, contracture is not only released but often turns into the converse contracture with astounding ease. In these cases the balance between agonistic and antagonistic muscle groups is extremely labile; some authors speak of a spasmus mobilis,—a shift of contracture position (Figs. 4-A and 4-B). The fingers may change from flexion to extension contracture,

FIG. 4-A

FIG. 4-B

Spasmus mobilis. Alternation of contracture position in spastics. Fig. 4-A showing flexion. Fig. 4-B showing extension.

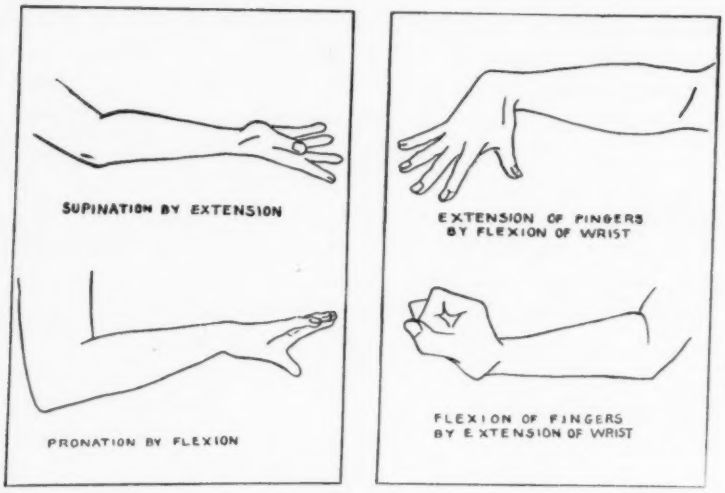

FIG. 5

Substitutionary motion of forearm and fingers in spastics.

the forearm from pronation to supination. This is one of the reasons for the difficulty in obtaining, either by conservative or operative means, permanent balance between antagonist muscle groups. In the hemiplegic, as long as the active mobility of the extremities has not returned, the formation of the contracture position depends, according to Förster, entirely upon the casual position of the limb and the perseverance in this position. But, as time passes and the position remains the same, tension in the muscle becomes greater and fixation becomes more firm. In contractures of the fingers in old cases of hemiplegia, the fingers often have an extended position against the thorax while the thumb shows adduction and flexion. There are many instances in which the opposite contracture can be seen, although adduction of the arm, flexion of the elbow, pronation of the forearm, flexion of the wrist, and the turning in of the thumb, are by far the most usual contracture positions. When voluntary motion of the antagonist returns, another factor enters into the play. In the upper extremity this return occasionally changes the flexion position, and the fingers are held in extension; or, at least, the flexion contracture of the fingers and wrist becomes mitigated. With the return of voluntary motion substitutionary motions also assume a meaning and can be used for the execution of movement which ordinarily would not be feasible. The background of this substitutionary motion for the hand is the development of passive tension and of passive insufficiency on the part of the extensor muscles (Fig. 5).

In general, the muscles most prone to contractures are those entrusted with holding posture. These are preeminently the short-bellied, uniarticular muscles,—brachialis, pronators, supinator radii brevis, and the flexors of the wrist. The pluriarticular muscles of the fingers, which have long bellies and are entrusted more with the dynamic functions, are less prone to produce contractures.

From the practical viewpoint it must be inferred that operative methods, which can only crudely redistribute balance, must encounter great difficulty in maintaining a muscle equilibrium of such extreme lability. A relief from the accumulation of efferent stimuli may be obtained by posterior root resection, or the efferent stimuli may be equalized by selective nerve resection. But these can only be preparatory steps for the all important muscle educational program. It seems, also, that the unsatisfactory results of muscle transference in this type of hand contractures can be explained on the ground of lability of balance, which makes the functional readaptation of the transplanted muscles very difficult. Reeduction of the old and opening of new and substitutionary pathways of nerve impulses by muscle training is the principal treatment. Fortunately, the hand is a very docile instrument.

III. CONTRACTURES FOLLOWING MYOSITIS. (ISCHAEMIC CONTRACTURES)

There are some physical aspects to be added to this group involving changes in the inherent mechanical properties of muscle tissue. First of all, in ischaemic myositis we deal with a true structural contracture. From its inception, it is not a contraction; it is a passive state. The relation between is otropic and anisotropic bands of cross striation is not that of the contracting muscle; it is that of the resting muscle. Also, it can be shown that the contracture is maintained at minimum expenditure,—there is no action current or fatigue.

Exact data of measurements and calculation of the changes of the elasticity in myositis, such as are found in ischaemic contracture, are not at hand; but clinical experience teaches that the elasticity is greatly decreased and the muscles offer considerable resistance to elongation. The elasticity module corresponds to that of the non-innervated, inert, muscle substance and the graph indicating the ratio between length and load shows a parabolic curve.

For practical purposes, the conclusions can be drawn that the myositic contracture will require continuous and steady counterforces for correction and that the resistance to correction will increase rather than decrease with improvement of position; this is quite in contrast with our experiences in spastic contractures.

Analysis of Ischaemic Contractures of the Hand.

Where there is no involvement of the ulnar and median nerves the contracture develops strictly on the basis of the myositic changes in the forearm and finger flexors. The sequence is usually as follows: first, there appears a flexion contracture of the wrist and flexion of the mid and end phalangeal joints; later, follows the extension contracture of the metacarpophalangeal articulation with retraction of the knuckles. The angular positions of the three finger joints do not correspond to the relation of their respective rotation moments (seven to five to one). Also, the ratio between natural fiber

length and maximum amount of shortening, which is the index for the efficiency of the muscle in its natural amplitude, has changed, due to the severe parenchymatous and interstitial degeneration of the muscle.

The hyperextension in the metacarpophalangeal articulation is largely the result of passive insufficiency of the extensor group, and need not indicate loss of interossei action. However, paralysis of the ulnar nerve often complicates ischaemic paralysis, causing the claw formation to become much more accentuated. In this case, we also see that the flexion in the interphalangeal joint is very much stronger, not being resisted by the extensory action of the interossei. The extreme flexion holds the end phalanx in immobile position, and provides practically a peripherally fixed point of application, comparable to a peripheral external resistance—the closed kinetic chain of v. Baeyer. In order to solve the problem of this contracture complex, it is above all necessary to eliminate this element of peripheral resistance and to free the phalanges from external restraint. The key to the situation is, here again, the flexion contracture of the wrist; upon it all of the subsequent features of contracture are superimposed. With returning dorsiflexion the passive insufficiency of the stretched finger extensors is removed. This does away with the hyperextension in the metacarpophalangeal joints, and is partly responsible for the extreme flexion contracture in the end phalangeal joint and for the closing of the kinetic chain.

IV. ARTHROGENETIC CONTRACTURES OF THE WRIST AND FINGERS

This type is to be considered from the viewpoint of secondary muscular involvement and its effect upon joint position rather than from the view-

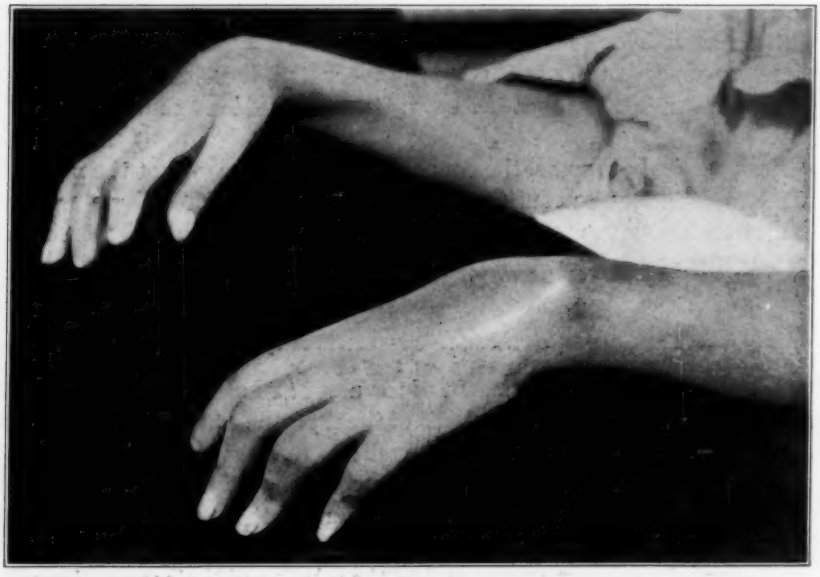

FIG. 6

Arthritic wrist contracture. Extension contracture of the end phalangeal joints from peripheral resistance.

point of the primary arthritic position. In the primary contracture of the acute and subacute stage the muscles are hypertonic. It is a measure of defense to place the joint in a position which approaches the neutral point for all muscles. In tuberculosis of the wrist the position is found to be one of slight flexion and ulnar abduction.

The hypertonic fixation contractures of earlier stages of joint affections are much easier to manage because, under constant traction, they yield to resistance in a manner similar to the spastic contractures. It is very different in the later stage of true contracture, because the histological changes in the muscles make passive stretching difficult.

Most of the contractures are flexion contractures of wrist and fingers, since the preponderance of muscle power and of the rotation moments is on the flexor side. But, here also, positions are frequently found to be materially different from the expected type. Closer analysis shows that these contractures of wrist and fingers could not develop from the inherent muscle contracture alone, but that external forces—particularly gravity—and external resistances must come into play; for instance, the hand may rest against the stomach, or against the thigh. Such external peripheral resistances, which close the kinetic chain, materially influence the type of contracture. In the arthritic hand several types of contractures are seen,—extreme ulnar abduction, flexion of the wrist, hyperflexion of the fingers, and claw hand; in some cases, there is hyperextension of the mid-phalangeal articulation. The latter type is particularly interesting. As long as the finger joints are free to follow the contracting interossei, the pill-roller hand develops. The wrist must be free to assume a straight or slightly dorsiflexed position in order to relax the extensors; otherwise, no extreme flexion in the metacarpophalangeal joints could develop. Now, if the fingers meet with

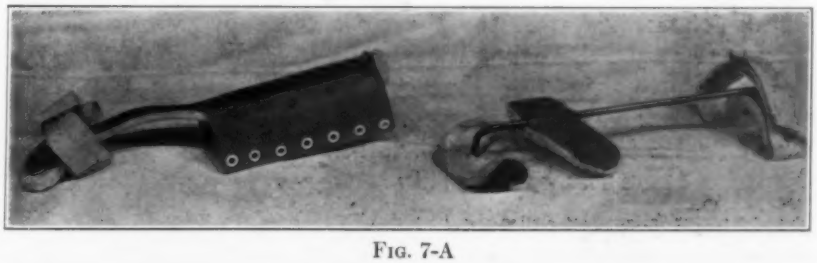

FIG. 7-A

FIG. 7-B

Splint: rigid type. Three-point application principle.

external peripheral resistance, the mid and end phalanges of the fingers are forced into hyperextension. Loose-jointed fingers, made still looser by the attending arthritic atrophy of the long-finger flexors, are particularly susceptible to these external resisting forces. This is an instance where the factor of the common relaxation field assumes practical significance (Fig. 6).

V. THE APPLICATION

These theoretical points have not so much bearing upon the detailed construction of the apparatus as they have upon the policy and principles under which the management of upper extremity contractures should be carried out.

In the first place, all contractures are complexes, and they all have a basic or key contracture which, in most instances, is the flexion contracture of the wrist or of the metacarpophalangeal joints. Any of the splints and appliances which carry out the principle of three-point application will, if constructed properly, serve the purpose of gradual and consistent correction. The point is: shall it be a persistent, positional correction, comparable to the action of corrective casts; or shall it be elastic traction, such as has recently been elaborated by Mommsen in his so called "Quengel" method? From the nature of the contracture it would appear that preference should be given to the methods of elastic, continuous traction, except where a great amount of correcting force is necessary, and where the application of this traction principle meets with technical difficulties.

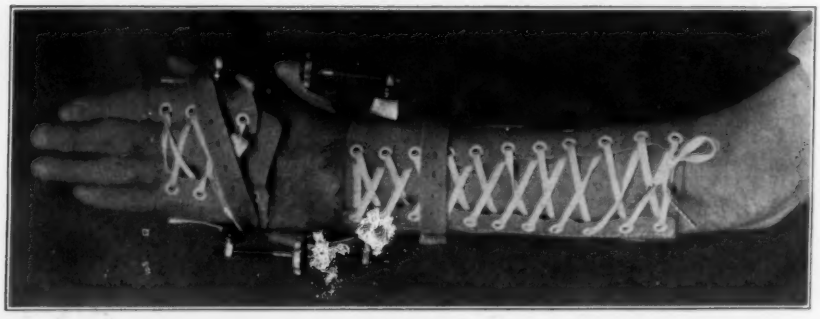

FIG. 8-A

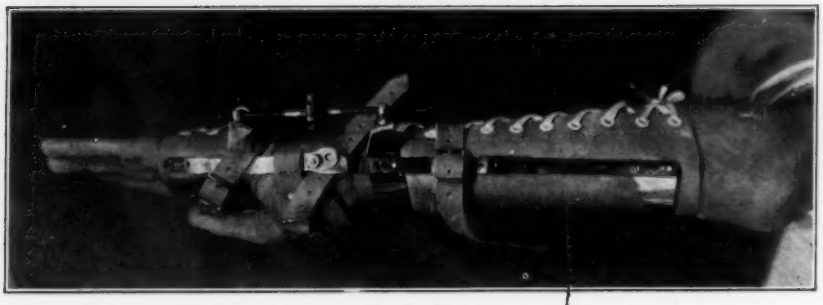

FIG. 8-B
Wrist splint. Turn-buckle type.

From theoretical considerations it further follows that in the preshrinkage stage of contracture in infantile paralysis, and in spastic paralysis, the attainment of correction is comparatively easy; it is much more difficult in ischaemic and in late arthritic contractures. It must also be realized that the uniarticular muscles, with comparatively short muscle fibers and a greater rotation moment,—a greater "specific shortening"—will develop much more resistant contractures than the pluriarticular muscles,—*i.e.*, that pronation contractures and wrist flexion contractures are, on the whole, less easily amenable to conservative correction by apparatus.

FIG. 9-A
Fingersplint: banjo-traction type.

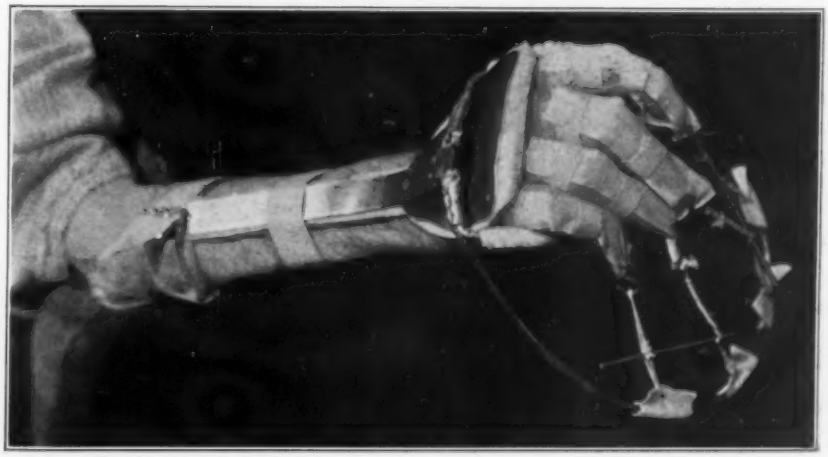

FIG. 9-B
Fingersplint: banjo-traction type.

What are the Limits of this Conservative Treatment?

Our experience in general has been that, if the conservative treatment is carried out persistently and judiciously, it yields better results and has a much greater scope of usefulness and efficiency than it is generally accredited with. This is particularly true of the ischaemic contractures. Moreover, the conservative treatment is the only treatment which can lay claim to a true physiological recovery by restoring the normal muscle-fiber length and its normal amplitude and efficiency.

A variety of upper-extremity appliances is being used. The body of the splint for the hand and finger is usually of the cock-up type, fastened to palm and forearm with straps and cuffs; the special corrective device, whether it be a flat finger splint or an elastic windlass arrangement on a banjo frame, is then superimposed upon the cock-up part. In contractures of the upper extremities, especially in those of the fingers, it is good policy to change position from time to time to avoid opposite contractures. Splint correction and muscle reeduction are at all times closely interwoven (Figs. 7-A, 7-B, 8-A, 8-B, 9-A, and 9-B).

Only after the full exploitation of the combined splint and exercise treatment, can the limits of the conservative treatment of upper extremity contractures be defined.

The Operative Release of Contractures

1. *Tendon Lengthening.* From the preceding remarks it should be obvious that the operative lengthening of a tendon for the purpose of releasing contracture does not reestablish physiological conditions. The muscle is thereby rendered too short for its tendon; whereas it previously had offered passive elastic resistance (passive insufficiency) to the restoration of the normal mid-position, it has now become actively insufficient for all, including the neutral, positions. This does not abrogate the merit of the procedure; the restoration of form is gained, but it is paid for with a certain

FIG. 10-A

FIG. 10-B

Ischaemic contracture treated only conservatively. Wrist range after treatment.

FIG. 11-A

FIG. 11-B

FIG. 11-C

Ischaemic contracture treated conservatively and with lengthening of the wrist flexor tendons.

Figs. 11-A and 11-B, before treatment.

Figs. 11-C and 11-D, after treatment.

FIG. 11-D

loss of function. Still, in the upper extremity, a great deal of adaptation is possible. In any event, the operative lengthening is a last resort. Tendon-lengthening operations are performed, principally, in spastic contractures where a decrease of the muscle power is desirable,—as, for instance, in the flexion contracture of the hand and in the adduction and flexion contracture of the thumb. In cases of ischaemic contractures, it is used only to correct as much as possible the flexion deformity of the wrist; tendon-lengthening operations of the long-finger tendons are being avoided because of the loss of muscle power which this procedure entails (Figs. 10-A, 10-B, 11-A, 11-B, 11-C, and 11-D).

2. *Tendon Stripping Operation for Upper Extremity Contractures.* Here, principally, the stripping operations upon the forearm flexors and pronators are used in ischaemic contractures and contractures in spastic paralysis. The common head of the forearm flexors, together with the humeral head and the pronator radii teres, is stripped from the internal

condyle of the humerus and replaced downward, with due regard to their innervation by branches of the median nerve.

3. *Alcohol injections and motor nerve resections to overcome spastic contractures.* This is a procedure confined to the motor branches of the ulnar nerve which supplies the intrinsic muscles of the hand. It is carried out in exceptional cases—as in the strong, intrinsic muscle contracture of the arthritic —and, occasionally, in cases of spastic paralysis of the hand. Alcohol injections produce a temporary loss of the muscle tone and facilitate the treatment of the pill-roller hand contracture.

4. *Juxta-articular Osteotomies.* A few selected cases of intractable claw-hand contracture have been subjected to this procedure. An osteotomy performed just proximal to the head of the metacarpals permits a volar deflection of the joint line, compensating for the retraction of the basal phalanges.

5. *Simple myotomies.* This operation is indicated only in very special cases,—as, for instance, in order to overcome a shrinkage contracture of the pronator quadratus muscle. The pronator radii teres, on the other hand, can be stripped off or lengthened, so that the use of this muscle is not entirely lost.

These surgical procedures are merely devices to correct contractures which elude conservative efforts and they have nothing to do with the problem of restoration of muscle balance,—such as tendon transplantations and arthrodesing operations. The discussion of such procedures is outside the scope of this paper.

We wish merely to state that, in most situations, the program of release and correction of contracture should be pursued independent of that of the restoration of balance, and should certainly precede it. When the contracture is released, whether it be spastic, ischaemic, or paralytic, a new situation arises which opens wider possibilities for the rehabilitation of normal muscle balance by educational and conservative methods.

CONCLUSION

In conclusion it may be pointed out again that the stated theoretical facts have a wide practical application. They are fundamental in formulating the program of treatment, not so much in regard to the technical construction of external appliances, but rather because the pathomechanics of these upper-extremity contractures point out the causal relationship of the different components of the contracture complex. By recognizing a basic or key element upon which the whole complex is built, we can decide on the most efficient point of attack for the correction. The biophysical theory of contracture gives information also as to when and how long mechanical correction is to be applied, and what changes of position conform best to the mechanical situation. It is safe to state that only by understanding the biophysics of these conditions, can one become efficient in their management and treatment.

THE HISTORICAL DERIVATION OF THE PHYSIOLOGICAL PRINCIPLES UNDERLYING THE TREATMENT* OF FRACTURES

BY R. PLATO SCHWARTZ, M.D., ROCHESTER, NEW YORK

Individual experiences frequently prove to be fallacious. Because of this, we can most safely determine our course from a summary of the facts accumulated on the treatment of fractures. Our objective in the treatment of these injuries, in their various locations and degrees of severity, is always the restoration of function without deformity. Only those physiological principles on which there is authority for acceptance shall be seriously considered.

HISTORICAL REVIEW

Such an approach in search of facts available on any subject requires a summary of work done. This includes related fields. The story begins in 1737 when Duhamel[1], a French lawyer, reported his first results from feeding madder to animals and fowls. Through this and later reports, he sponsored the opinion that periosteum was the maternal tissue of bone. Haller[2], Professor of Anatomy in the University of Göttingen, was stimulated in conducting similar experiments. From the results, he believed that periosteum had no osteogenic function. This was in accord with the prevailing opinion expressed with finality by the master surgeon Cheselden[3] in 1741. Bones "are covered by a fine membrane, which upon the skull is called pericranium, elsewhere periosteum. It serves for the muscles to slide easily upon; it is everywhere full of small blood vessels which enter the bones for their nourishment." The growth of bones proceeds "by the continual addition of ossifying matter; they increase until their hardness resists a further extension; and their hardness always increasing while they are growing, the increase of their growth becomes slower and slower until they cease to grow at all. In all fractured bone, in which the same kind of matter which ossified the bones at first is thrown out from the broken ends, there is formed a mass of callous matter."

It is of interest and particular significance that emphasis be placed upon these facts: Almost two hundred years ago periosteum was recognized as a vascular membrane from which the underlying bone received blood vessels. The growth of bone was not different from other living tissue which developed by a filling up and expansion of the interstices. The repair of a fractured bone resulted from the formation of callus which ossified. This summary may be accepted as an expression of that which was known about bone growth when Duhamel and Hunter began their animal experimentation and clinical observations on bone growth and reaction to injury. Thus was started a controversy which is still represented by two schools of

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thought, although constant effort has sought settlement for nearly two hundred years.

As early as 1779, there was expressed, by Jean Pierre David[4], the opinion that rest and action represent nature's two resources in the repair of an injury. Each of these opposing states had a proper time and place in the treatment of disease.

John Hunter[5], 1768, was in complete agreement with Haller. His experimental work began and ended with the conviction that periosteum had no osteogenic power, — it was a fibrous membrane surrounding bone which the blood vessels nourished. In connection with these experiments he was first to observe one of the fundamental powers of living tissue, — the removal and absorption of portions of their substance. The results of experimental work on madder-fed pigs revealed to him that "living bone is constantly changing its matter". Because of this he emphasized that normal bone growth must include absorption as well as the deposition of osseous tissue. The removal of products by absorption was shown to take place through the lymphatics rather than the veins.

Hunter then became interested in the experimental study of the repair of fractures. His conclusions were in close agreement with those of Duhamel, except that in the end he presented the broader view. Both men recognized: (1) the presence of a blood clot between the fractured ends and surrounded by a periosteal bridge; (2) the clot was seen to be "organized" by the formation of blood vessels, small arterioles; (3) these vessels came from muscle, periosteum, cortex, and endosteum; (4) as the callus grew older, bone was usually first formed at the ends of the fracture, but it also occurred deep within the callus. It will be recalled that he was a disciple of Haller, who held that bone could be formed around any arteriole. He seemed indifferent, therefore, as to where arterioles came from, — periosteum, muscle, cortex, endosteum, or medulla. These and subsequent conclusions made from animal experimentation and clinical observation formed a rational basis for those who were to follow Hunter.

Duhamel was less liberal in contending that the callus was a product or secretion of the periosteum; all adjacent structures were passive in the process of repair.

One hundred years later, 1834, Charles Bell[6] stated that "a bone may be taken to prove that in nature's work strength is given with the least possible expense of materials. Nature, solicitous of our safety, combines with the perfect muscular frame a dense and perfect texture of bone . . . . The inert and mechanical provision of the bone always bears relation to the living muscular power of the limb." This is an index of the trend of thought which, fifty years later, culminated in a more concise statement by Julius Wolff[7]. As Professor of Orthopaedic Surgery in Berlin University, he was chiefly interested in the results of careful investigation, including animal experimentation. In 1885 Wolff concluded fifteen years of work directed toward the formulation of a law governing the transformation of bone. The alteration of internal structure, which always accompanies

deformities of bone, first received his attention. Thus stimulated, his work continued until he proved the presence of secondary external changes adapted to function in the new position. In its final form, Wolff's law of bone transformation, in its usually accepted translation, reads:

> "Every change in the form and the function of bones, or in their function alone, is followed by certain definite changes in their internal architecture, and equally definite changes in their external conformation, in accordance with mathematical laws."

The results of Ollier's work at Lyons, on experimental fractures, were published in 1867[8]. He concluded that: (1) periosteum produced the greatest amount of callus; (2) the endosteum was next in importance; (3) while the cortex was the least active in restoring continuity of a broken bone. It should be noted, therefore, that this was essentially the same opinion expressed by Duhamel in 1737.

Macewen[9], of Glasgow, made a discovery which at least made this question less definitely settled. In 1878, a three-year-old, emaciated boy was brought to him with a suppurating osteomyelitis of the right humerus. The shaft was removed, leaving the distal epiphysis and a small part of the proximal end with the humeral head. Two years later, in 1880, the right upper extremity was useless. For this reason the patient was returned for amputation of the extremity. Being courageous, as well as a skillful surgeon, Macewen had an alternative course. Through a longitudinal incision on the lateral aspect of the arm, he found no evidence of regeneration in any part of the area of excision. The distance between the proximal end and the distal epiphysis was filled in with pieces of bone which had been removed from the curved tibiae of previous patients. The age of these bone fragments is not known, but it is stated that the periosteum was not on all of them. Although this operation was performed thirteen years after Lister[10] announced his discovery of wound infection (1867), the wound healed, the grafts became viable and grew into one continuous bone, connecting the proximal and distal ends, representing a total length of six inches (15 cm.); four and one-quarter inches were formed by the tibial grafts. Thirty years later; *i.e.*, in 1910, the patient was a capable workman thirty-five years of age. He had a useful, slightly curved, but well-formed humerus eleven inches (27.5 cm.) long. His right arm was three inches (8.5 cm.) shorter than the left.

It was thus for the first time shown that bone fragments may be used as grafts which become viable, develop, and form, or lead to the reproduction of, bone. We might refer at this point to Wolff's law by calling attention to the fact that these tibial grafts lead to the development of a real humerus of essential anatomical characteristics and physiological requirements.

The brevity of this review covering the development of knowledge relative to the growth and repair of bone is more necessary than desirable. While it reveals differences of opinion which still prevail, there is expressed the more important fact relative to the prevailing attitude of mind which governed the treatment of fractures.

It was during the fifteen years between 1876 and 1891 that Hugh Owen Thomas[11] created a school of thought which continues to have many followers. His doctrine of "enforced, uninterrupted, and prolonged rest" was practised as a religion. This principle was carried out by strict, systematic, and complete application in the treatment of each successive case. In the methods of promoting rest, Thomas was fastidious and critical. He insisted that while immobilization was essential for rest, its application should always be attained without constriction of the extremity or compression of its circulation. He, therefore, was always opposed to the use of plaster which was the prevailing practice in France. This conviction was not an unfounded prejudice. Thomas fortunately was Hunterian in his attitude toward the treatment of patients, believing, as we well know, that the repair of injury is an inherent property of living tissue. His earlier practice was marked by the use of plaster. From this he learned the dangers associated with swelling of the fractured extremity, impairment of circulation, sloughs, with or without long-continued suppuration and threatening loss of the extremity. The Thomas splints are known to all of us fifty years after definition of principles upon which their creation was based.

He observed that movement at the site of fracture resulted in the formation of an exuberant callus. In union of fractures, he therefore adopted the practice of percussion at frequent intervals over the line of fracture. In 1876 he introduced the method of "damming" in the treatment of delayed union of fractures, which practice was continued until his death in 1891. Twenty-seven years later, 1903, Bier[12] again started this method of treatment. He developed mechanical devices to facilitate its use and today the principle first applied by Thomas is known as Bier's hyperaemia. Thomas for a time operated on fractures of the tibia and fixed them by pegging; this method was not long continued.

Control experiments must be used to confirm the value of treatment previously based on clinical observation. The experimental work reported by John J. Morton and S. J. Stabins[13] in 1927 was the first which revealed the indications for the Thomas method of "damming" ununited fractures.

In his day the principles enunciated and so precisely practised by Thomas were given second place in England. A movement initiated in New York by H. G. Davis[14], C. F. Taylor[15], and Lewis Sayre[16], about 1864, gained popular favor with his contemporaries. It was this New York school which fostered the use of extension as a method of fixation for resting disabled limbs.

It is evident that the late nineteenth century found agreement in the principle of rest and immobilization for the treatment of fractures, although there was difference of opinion as to the methods of application.

This professional serenity proved to be of short duration. The disturbance came from France in 1867. Lucas-Championnière[17] had his attention called to a woman, age sixty-six, who suffered from a fractured

radius. Without splinting, and with no rest of the affected region, she presented a perfect result. He then treated fractures of the fibula with movement instead of by rest and splints. The following year, 1868, he visited Lister in Glasgow and returned to Paris fully converted to the importance of the new discovery. By the application of Lister's methods he began treating compound fractures. Study of the processes of bone repair and the effect of rest on the healing of fractures was then placed before him in the depths of healthy wounds. He was convinced that slight motion at the site of fracture favored acceleration more than retardation of the progress of repair. He ultimately condemned the principle of rest by immobilization as bad. This seemed to be true because he held that motion was essential for a healthy state of cartilage, ligaments, muscles, and other specialized structures upon which function of an extremity is dependent. One by one, he abandoned all splints in favor of motion and massage, except for fractures of the tibia and femur where relatively small splints gave slight evidence of effort to immobilize the part affected.

Accepting the opposing differences in principles pertaining to the treatment of fractures, professional opinion was essentially unchanged for approximately thirty years.

Such differences in attitude toward the principles underlying the treatment of fractures in the year 1890 cannot pass without a further comment. Going back one hundred years to 1788, we found Jean Pierre David with the conviction that rest and motion have respective and equally important places in rational therapy of fractures. This was followed by the doctrine of rest through complete immobilization, with little or no emphasis on the advantage of motion in restoration of function. This attitude dominated for half a century, at the end of which it was attacked by an opponent which threatened its continuation. Lucas-Championnière made rest the adversary of a healing fracture, — motion its ally. How could these opposing views be justified? Which doctrine should be followed? Undoubtedly the answer was given by David in 1788 before the question was asked in 1890,— rest and motion have respective and equally important places in the rational therapy of fractures. This has come to be the accepted point of view.

There remain two principles yet to be considered: the application of internal fixation of fractures, by (1) metal plates, and (2) the use of bone grafts and other materials for internal fixation.

These operative procedures have been rightfully praised and condemned. In 1894 Arbuthnot Lane[18] applied the first metal plate and screws to the internal fixation of a fractured tibia. This started a wave of disturbance in the quiet waters of conservatism in the treatment of such injuries.

In 1911 F. H. Albee[19] of New York introduced the use of living bone grafts as agents of internal fixation. It will be recalled that Macewen in 1880 revealed, by his classical case of the humerus, that tibial grafts from other patients might be expected to grow or lead to the development of

bone when properly transplanted. Both of these methods have merit but neither one is free from objection. That each one should be limited to selected cases is generally admitted. Their true relationship to conservative measures may not at present be dogmatically stated.

The physiological principles governing the treatment of fractures is therefore based upon the interpretation of reaction of tissues to injury. But this interpretation must be made in terms of the functions served by all the tissues in the affected region.

Trauma, direct or indirect, sufficient to produce a fracture, must of necessity injure to varying degrees the surrounding soft parts. Such injury means solution of continuity of bone with laceration or elevation of periosteum, plus damage to adjacent muscles, tendons, fascia, directly or indirectly involving these structures, and the cutaneous surface by subsequent swelling due to hemorrhage.

The purpose which this summary serves is to make articulate some practical working plan for the treatment of fractures.

The principles enunciated by Thomas are still practiced by his son-in-law, Sir Robert Jones, in Liverpool. There is general acceptance of the favorable influence of anatomical reduction on subsequent union of a fractured bone. This includes restoration of the normal axis of the extremity by proper alignment with consequent protection of joint movement from abnormal strain, and the preservation of unaltered lines of contraction for the adjacent muscles. It is granted that the restoration of function without deformity is most assured when these conditions prevail. The question which has confronted the profession, since the requirements were recognized, is: By what treatment can we be most assured of creating these conditions?

The first expression of an effort to answer this important question was revealed in 1911. This was sixteen years after Lane had first used metal plates in open reduction. The British Medical Association[20] appointed a commission to investigate for comparison of results by treating fractures by: — (1) manipulation and immobilization by use of splints; (2) direct operation; and (3) massage and immobilization.

Two years later, 1912, the answer was given. The result of treatment was based upon the age of the patient and included 147 cases treated by Lane's method together with 2596 cases in which conservative or non-operative therapy included the usual methods of immobilization. The figures revealed that operation or open reduction was contra-indicated in patients under fifteen years of age. The statistics favored open reduction in adults.

This report may have been influenced by the advantage given by open reduction for securing absolute anatomical reduction. The inter-relationship of adjacent structures in an extremity is an anatomical fact. Normal function subsequent to a fracture can be most assured only when perfect method aims at the direct restoration of the original relationship. When attained, there is prevented the necessity of nature making changes in all

adjacent and related parts to conform with shortening or malalignment. This attempt of the surgeon to give nature every advantage to produce a perfect result seemed theoretically perfect. The intervening years have revealed limitations so that today it is usually agreed that open reduction, with or without Lane plates, is not the first method to be considered in the treatment of fractures.

The second evidence of a conscientious group effort to answer the question of how to treat fractures was expressed in April 1922. Twenty-six men, representing eight states, held a conference in Boston. A syllabus in the form of an Outline of Treatment of Fractures was presented and agreed upon. To those of you who have problems in this field it would probably prove helpful. The report was published in *Archives of Surgery* VI, 172 (January 1923).

I quote from the article as follows:

"I. First Aid.

Every effort should be made to avoid any injury additional to that of the original trauma.

1. 'Splint 'em where they lie.'
2. Avoid every unnecessary manipulation.
3. Transport with extreme care.
4. Treat any existing shock.

II. Examination.

As complete and thorough an examination as possible should be made without causing any additional injury.

1. Begin with painless procedures.
2. Search for crepitus and abnormal mobility only when these symptoms are absolutely essential. The manipulation required to elicit these may cause additional injury.
3. Rule out, if possible, other associated injuries, especially those of nerves.
4. Elicit objective symptoms, which will be painful, only under an anaesthetic.
5. Roentgen-ray examination should be made as early as possible; roentenograms should be taken in two planes, stereoscopic when necessary; should be of sufficient size, and should be studied with detailed care.

III. Diagnosis.

The simple diagnosis that a fracture exists is not sufficient. All details of pathology of the soft parts, as well as of the bone, should be considered, so as to visualize properly the problem of obtaining and maintaining reduction as well as the problem of repair and its probable duration.

IV. Treatment.

Each fracture should be considered as an individual problem and the treatment directed not only to the injury of the bone but to that of the soft parts as well. The pathologic changes following a fracture interfere markedly with the ease of reduction of displaced fragments. These changes begin very soon after the injury. Infiltration of the adjacent soft parts, coagulation and later organization of the blood are the most important.

1. Obtaining Reduction.
   (*a*) Reduction of any existing displacement should be made as soon after the injury as possible, without waiting too many hours for the roentgen-ray examination.
   (*b*) Reduction should be as gentle as possible.
   (*c*) Reduction should be as complete as the individual case requires.

(*d*) Reduction may be controlled by fluoroscopic examination in appropriate cases.

(*e*) Reduction should be checked by roentgen-ray examination as soon as practical.

(*f*) Manipulation should be carried out under an anaesthetic with but few exceptions.

(*g*) Further attempts at reduction should be made as soon as the need is recognized.

2. Maintaining Reduction.

(*a*) Decide in each case the peculiar problem presented, and select apparatus accordingly, both for immediate and subsequent use.

(*b*) A decision should be reached as to how early such apparatus can be temporarily discarded to allow for massage and motion, and how long it should be worn, in order to protect against further injury.

(*c*) Repair in cancellous is more rapid than in cortical bone.

(*d*) Rapidity of repair will depend very largely on the blood supply of the fragments.

(*e*) The atrophy of disuse must be borne in mind.

(*f*) The inherent value of any apparatus is of less importance than the skill with which it is used.

3. Plaster-of-Paris.

Circular plaster bandages are permissible only when completely divided in at least one line.

4. Massage and Movements.

If carefully and gently carried out, massage and movements can be of the greatest help. If roughly performed, they may do considerable harm. One must differentiate under massage, between:

(*a*) Gentle stroking without deep pressure.

(*b*) Stroking with deep pressure.

(*c*) Kneading.

One must differentiate between:

(*a*) Guided active motion.

(*b*) Unaided active motion.

(*c*) Passive motion.

With these differences in mind, the various forms of each may be begun as soon as there is no danger of any additional injury or any displacement of the fragments resulting. This gentle massage and movements may cause discomfort but should never cause actual pain. The pain of forced passive movements usually means harmful stretching or tearing of soft parts, with additional necessary repair.

V. Operative Treatment.

Operative treatment is indicated when a satisfactory reduction cannot be obtained and maintained by non-operative methods, provided there is no contra-indication, and when the expected result of the open method is sufficiently better than that of the closed to justify the additional risk.

Furthermore, it is generally recognized and accepted that, in certain types of fractures, it is impossible to obtain satisfactory restitution except by operative methods. The operative method is recommended to those surgeons who have had special training and experience, who have the necessary skill and judgment, and who have the hospital facilities and surgical armamentarium with which to do this work properly. In the case of those who do not have such facilities, operation is not advised.

Internal splinting of long bones is usually best made by fixation, with steel plates and screws, having a minimum of foreign material but with maximum strength and ductility. The machine type screw only should be used. The wood or so

called carpenter screws are contra-indicated in the cortex of bones. A scrupulous non-hand touch contact technique should be carried out with strict attention to detail. The skin should be carefully covered during the operation, and there should be special care and preparation of the skin before operation. Intramedullary fixation by bone graft or splints is contra-indicated if any other method is possible. Bone grafting is indicated chiefly in loss of substance and pseudo-arthrosis. It is not indicated in the treatment of acute fractures. Every attempt to stimulate osteogenesis should be exerted before attempting to bone-graft for delayed union.

VI. Compound Fractures.

In all compound fractures patients are to receive tetanus antitoxin.

Compound fractures in which it is perfectly evident that the wound of the soft parts is made by the protrusion of bone from within outward through the skin and in which the wound is tiny, should have a thorough preparation of the skin by washing with benzin, shaving (away from the wound), drying with ether and the application of tincture of iodin to the skin and the wound itself, with sterile dressing. Immediate reduction should be undertaken when indicated.

When a roentgen-ray examination is to be made before reduction, all the steps enumerated above, except reduction, are to be completed before the patient is sent to the roentgen-ray department.

In extensive compound fractures with a large wound:

1. Apply a tourniquet only when it is obvious that some large vessel has been lacerated.
2. With a sterile sponge, carefully protect the wound from contamination while the skin is being cleansed, following the foregoing routine; in addition, chlorinated soda solution 1 to 40 may be found of value in removing grease. If this procedure can be undertaken without too much pain and shock to the patient, it should be carried out before he is sent to the roentgen-ray department; if not, apply tincture of iodin only to the edges of the wound, and put on a large sterile dressing before roentgen-ray examination, and complete the procedure when the patient is under anaesthesia.
3. At operation, débridement:
   (*a*) Thorough exposure of wound by generous incisions.
   (*b*) Excision *en bloc* of traumatized and infected tissues.
   (*c*) Excision of skin at least 0.5 cm. from the wound edges.
   (*d*) Dead and dying fat, fascia, and muscle cut away with sharp instruments until fresh bleeding occurs.
   (*e*) Small bone fragments unattached to periosteum removed; soiled bone surfaces rongeured.
   (*f*) Hematoma dissecting between muscle planes should be carefully evacuated.
   (*g*) Frequent changes of gloves and instruments to insure against carrying infection into deep portions of wound.
   (*h*) Irrigation of the wound with salt solution to wash out particles of dirt, if necessary.
4. Final dressing of wound, according to indication:
   (*a*) Complete closure after lavage with ether or iodin.
   (*b*) Application of Carrel tubes for immediate use of surgical solution of chlorinated soda (Dakin's solution)."

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CONTRACTURES OF THE HAND FROM INFECTIONS AND INJURIES*

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Contractures of the hand usually result from infections. The infection may be primary or may follow traumatic tissue destruction. Contractures from burns involve essentially the skin and many include some deeper tissues. They are from without inward; while those from infections are primarily of the deeper tissues and secondarily involve the skin, either as the result of sloughing through, or because the incisions for drainage were placed so that they crossed flexion creases.

EFFECT OF INFECTIONS

Stage of Destruction

The longer the infection lasts the greater is the growth of granulation tissue and consequently the greater eventual cicatricial contraction. Therefore, we should terminate our infections quickly by accurate diagnosis, by choosing incisions which will drain each fascial space or tendon sheath adequately and still never cross flexion creases at right angles, as this leads to flexion contractures. We should, therefore, never make the median longitudinal incision whether in finger, palm, or wrist. Incisions should in the fingers be mid-lateral; in the palm parallel to the flexion creases and L-shaped for open drainage, and, if the wrist must be crossed, it should be done in a curved or zigzag line to avoid contracture. During the healing functionating positions should be maintained by splints, and intermittent exercise instituted early. The greatest damage from infection occurs in enclosed tunnels,—such as in the wrist or fingers. When tissue in such an inclosure swells, blood is excluded and ischaemia occurs, resulting in necrosis and sloughing.

When the palmar space is infected, the intrinsic muscles of the hand become paralyzed by being bathed in pus. This upsets the muscle balance and claw-hand results. As infection travels up along the ulnar nerve in the forearm, these same muscles are further paralyzed, resulting in increased deformity.

Stage of Healing and Contraction

The inflamed and granulation tissue throughout the hand and forearm gradually contracts, binding all of the tissues together in a dense octopus-like contracting scar. Just as the area of skin involved may shrink to two-thirds or one-half its size, so the deeper tissue—including deep fascia, palmar

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fascia, and the deep connective tissue which surrounds all structures—solidifies, shrinks, and draws to itself from all directions. Infected muscles shorten as they contract with fibrosis and also the parts of joint capsules which were involved in the infection. Tendons are reduced to contracting scars and attach themselves to the surrounding tissues. Tendon sheaths greatly proliferate and attach themselves to their surroundings and contract. Thus, all of the tissues may share in drawing the joints into flexion. This in the hand applies particularly to the wrist, the cleft between the first two metacarpals and the distal two joints of the digits.

Secondary Effects of Contractures

The infection follows blood and lymphatic vessels and nerves, especially the ulnar nerve. Granulation tissue forms around these structures and in the final contraction strangles them, impairing their function. The lessened nerve supply results in atrophy of all of the tissues, stiffening of the joints, and adherence of tendons. The lessened blood and lymph supply results in impoverishment of tissues, oedema, and cyanosis. The whole hand becomes firm, atrophic, cyanotic, and poorly nourished. In this so called congealed hand the joints become stiffened and the tendons adherent; and there is pain, paraesthesia, and diminished sensation.

In skin the irritation of the scar from intermittent tension results in keloid formation. Thus, where a scar crosses a flexion crease, every effort of extension increases the keloid formation and this, in turn, the contracture. The same is true of the deep cicatrix from connective tissue and in some people more than in others Secondary to contractures, muscle balance is upset. While one group of muscles is overstretched and weakened, the opposing group is allowed to contract and become fixedly so. In flexion contracture many tissues are involved. Some are primarily affected and others, including all from the skin to the capsules of the joint, follow secondarily, due to the flexed position.

The Rôle of Tendons in Contractures

A sloughing tendon is eventually replaced by a contracting cicatrix which attaches to the surrounding tissue and draws the joints into flexion. The tendon sheath proliferates greatly, and similarly attaches itself and contracts. Such a firm cord cannot be drawn out by continuous traction. Physiotherapy is useless. The damage found at operation is always worse than expected. Though the terminations of tendons left from sloughing always become fixed, severed tendons not in the presence of infection remain free or fixed according to whether they are severed in a sheath or in a paratenon formation. If severed in a sheath, the tendon ends will be found rounded over and without proliferation and free in the sheath. If severed in paratenon, however, the tendon will send out a pseudopodium which may be an inch or two long and considerably thicker than the tendon itself. This pseudopodium will attach itself firmly to whatever it touches and anchor the tendon end. If the tendon is severed where there is no

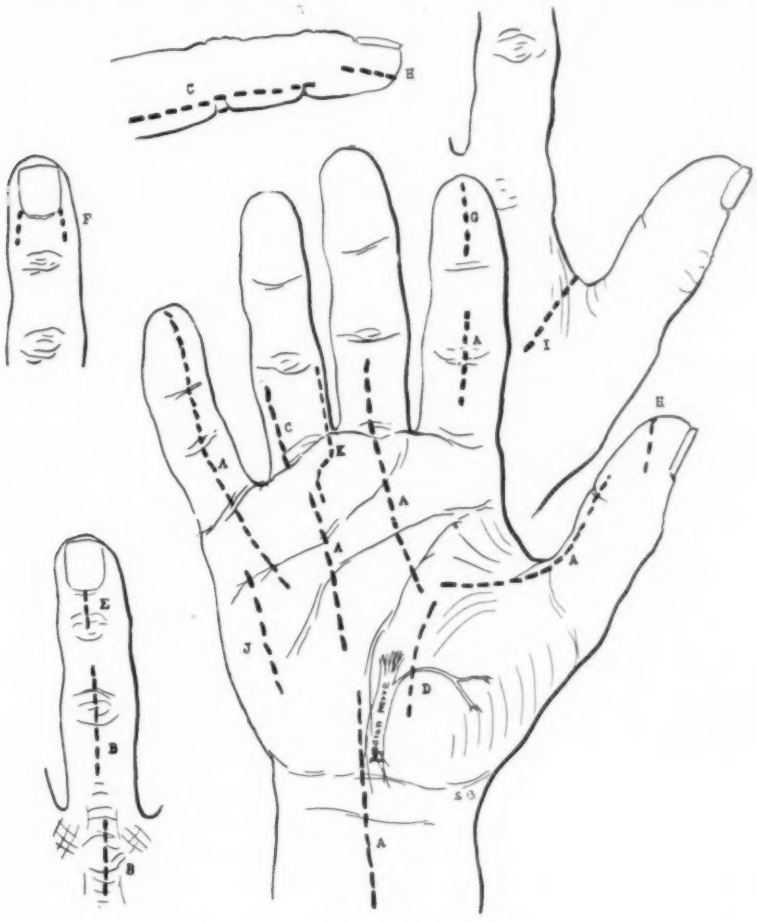

FIG. 1

A chart of pernicious or incorrect incisions in the hand, any of which will do harm.

A. Median longitudinal incisions which cross flexion creases at right angles and result in flexion contractures. These are prevalent but pernicious.

B. Median incision on dorsum of finger which later leaves a scar that contracts and hinders flexion of the finger. When present, it is impossible to fashion a proper skin flap under which to repair the extensor tendon.

C. Anterolateral incision in finger which is directly over and endangers the vessels and nerve. It is the usual one pictured for draining tendon sheaths, but should instead be mid-lateral.

D. Incision which thoughtlessly severs the motor thenar nerve and so robs the thumb of the power of opposition.

E. Median longitudinal incision through matrix will produce a ridged nail.

F. Incisions for paronychia often pictured, but erroneous, as they do not drain the bottoms of the clefts formed by the borders of the base of the nail which curve strongly forward.

G. Median longitudinal incision in pulp for drainage of a felon. It will not drain, as due to cleavage planes the pus progresses in spite of it and points dorsilaterally. Also, the scar resulting is in the tactile surface.

H. Alligator-mouth incision wrongly placed too far anteriorly which leaves a scar in the tactile surface.

I. Incision across a web injures the web which itself has a function of complicated foldings to allow for movements of thumb.

J. Incision often made for drainage of pus in sheath of tendon to little finger. The tendons, however, converge sharply in palm to pass between the ridge of the trapezium and the unciform process of the unciform bone.

K. Incision continuous from finger to palm severs nerve, thus rendering half of finger permanently anaesthetic.

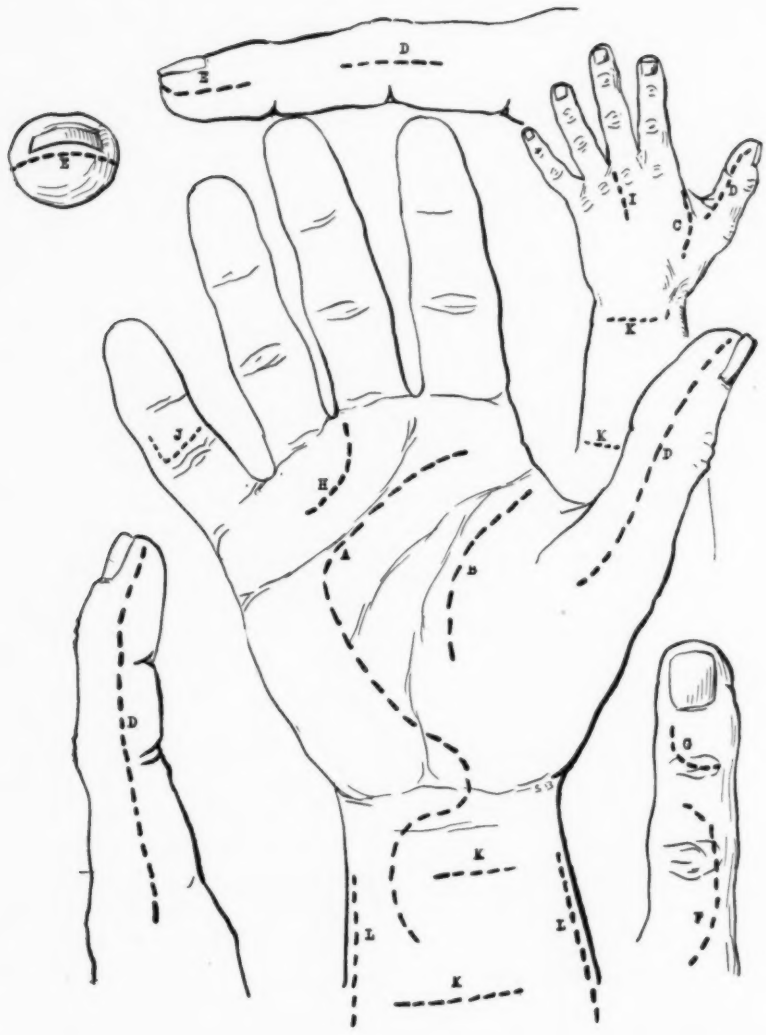

FIG. 2

A chart of advisable or correct incisions in the hand which will afford access and will not cause disability.

A. Incision for approach into palm for drainage of middle palmar space. It parallels the flexion creases, except in the immovable part or heel of the hand, allows wide opening by a triangular flap and can be prolonged so as to separate without severance the branches of the median nerve from those of the ulnar nerve. It may then be extended up through the annular ligament at its ulnar edge and up the forearm, as shown. It crosses the flexion crease in the wrist in a curve so as to avoid resulting in flexion contracture.

B. Incision for draining thenar space. It parallels the thenar crease, must not sever the thenar motor nerve and must leave pedicles sufficiently wide to nourish area of skin between it and incision for middle palmar space abscess.

C. Incision for part of thenar space dorsal to adductor muscles of thumb. It should be radial to the first interosseus muscle and stop short of cutting the radial artery as it passes through the first cleft.

D. Mid-lateral incisions in fingers and thumb which avoid volar nerves and vessels and do not produce flexion contractures. If made intermittently opposite the joints the annular ligaments or pulleys which are opposite the centers of the phalanges will be spared.

FIG. 2—*continued*

E. Incision for draining pulp abscess. One should cut across lateral fat columns, be posterior to tactile surface, and not cause tenosynovitis by nicking the sheath of the flexor tendon.

F. Flap incision for approach to extensor tendon in finger, so that the incision will be remote from the tendon.

G. Incision for approach to insertion of extensor tendon.

H. Palmar approach to collar-button abscess to give open drainage. Avoid cutting nerve to finger.

I. Dorsal approach to posterior part of collar-button abscess. It does not overlie the joint or tendon.

J. Flap incision for subcutaneous abscess. One arm should be median to nerve; the other blocks the upward progress of the infection.

K. Incisions in forearm for reaching tendons should parallel the fine wrinkling of the skin to be inconspicuous eventually and to avoid keloid formation.

L. Incisions for drainage of quadrilateral space in forearm. Entrance should be just anterior to bones and anterior to the radial nerve and posterior to the dorsal branch of the ulnar nerve.

gross paratenon but merely a thin slippery layer, as is seen in the palm, even here a thick, translucent, jelly-like tube, with walls one or two millimeters in thickness, will soon extend out as a pseudopodium and attach. Thus, if a tendon end or part of a tendon end not in a tendon sheath is "unsatisfied", it will by growth reach out and firmly attach itself. In an end-to-end suture of a small tendon to a large one, care should be taken to enclose the unsatisfied part of the large end or it will reach out as a pseudopodium, become attached to the surrounding tissues, and prevent motion. If one tendon becomes so attached, it will hold back the common muscle which pulls the tendons of the other fingers, and so will limit the action of all of the tendons. This is also frequently seen after amputation of a finger. The tendon attached to the stump has too short an amplitude of motion to allow full motion of the tendons of the other fingers. Also, attachment of a tendon will limit the action of its antagonist, whether it be flexor or extensor, and so will result in a contracture. The distal end of a flexor tendon left in a finger will contract and draw the finger into contracture. That part of a flexor tendon distal to an attachment always becomes adherent throughout the length of the finger.

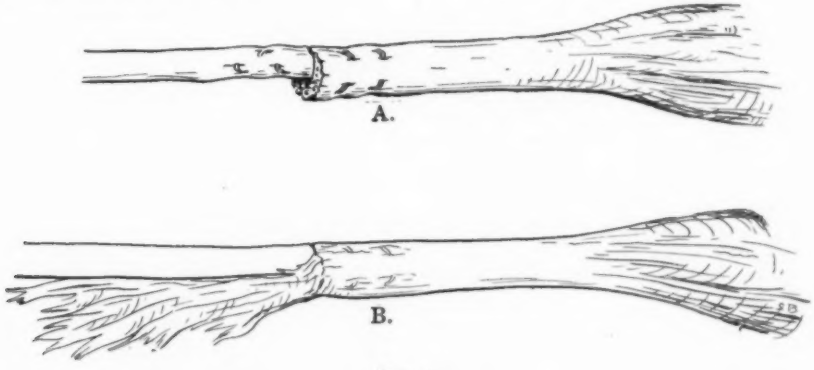

FIG. 3

If there is left an "unsatisfied" end of a tendon, or, in suturing together a small and large tendon, part of the latter end is left exposed or "unsatisfied" (*A*), that part will grow principally from its epitenon a pseudopodium (*B*), which will reach out and attach itself to the surrounding tissues and contract, so that the motion of the tendon will be checked.

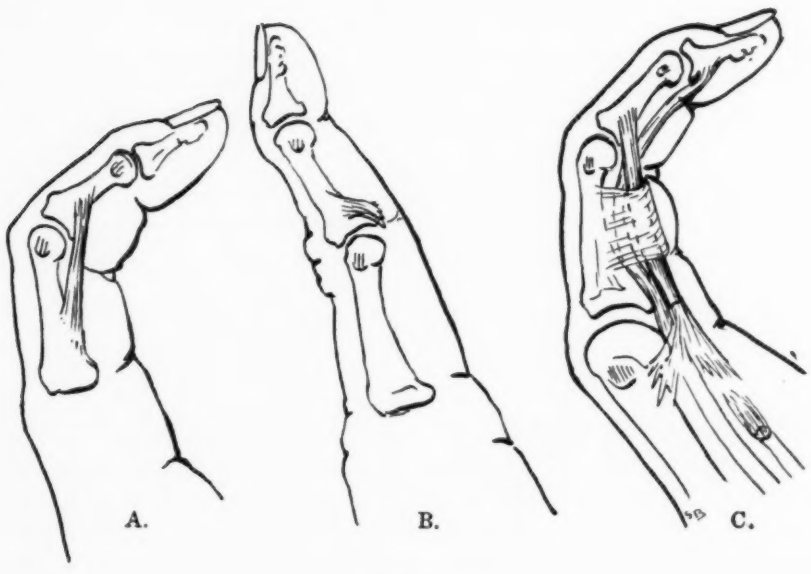

FIG. 4

In reconstructing tendons in a finger, usually the sublimis tendon must be removed in order to prevent inevitable adhesions between the sublimis and profundus tendons. The sublimis tendon flexes the middle joint and the profundus tendon the distal joint. Therefore, adhesions joining the two tendons will prevent action of the profundus tendon on the distal joint.

A. If the sublimis tendon is cut off too long, the distal end will attach itself to the proximal segment of the finger and draw the middle joint into flexion contracture.

B. If the sublimis tendon is cut off too short, the middle finger joint will overextend.

C. If the sublimis tendon is severed in the palm or base of a finger, the end of its distal portion will proliferate, attach and contract, producing a flexion contracture of the finger.

Volkmann's Ischaemic Contracture as a Factor in Infections

Volkmann's ischaemic contracture is unique because of the mechanism of its production. The deep fascia of the flexor aspect of the forearm, together with the bones and the interosseus membrane, constitute the tough wall of an enclosing space incapable of expansion and similar only to that enclosed by the dura mater. In the latter, decompression operations are done to prevent the brain from being damaged from ischaemia due to swelling following contusion or hemorrhage. A similar mechanism applies to the forearm and that is why Volkmann's ischaemia is found in this site only. When intense swelling occurs in this space, due usually to vessel obstruction from unreduced supracondylar fractures, and also from any cause—such as contusion, extremes of temperature, or infection—the contents of the space so swell that ischaemia is produced and consequently necrosis and partial necrosis of all of the contents of the space. Muscles are affected most, but nerves and other structures are not spared. After the initial intense inflammatory reaction and absorption of products of necrosis, contracting fibrosis occurs. The muscles undergo fibrous degeneration and are short-

ened; all tissues are bound together in cicatrix and the nerves are damaged and strangled, resulting in paralysis, glove anaesthesia, and atrophy. With this conception of Volkmann's ischaemia, it is not surprising that the process is a factor in any severe infection in the forearm.

TREATMENT

General Principles

Conservative methods of treatment alone—such as long continued, constant, mild traction—will draw stiff joints into functionating positions, will elongate soft cicatrices and contracting muscles, but will not draw out adherent cicatricial tendons; nor will physiotherapy, even if used by the

FIG. 5-A

FIG. 5-B

A.T. Showing the great improvement in the nutrition of the hand produced by dissecting out all of the deep cicatricial tissue from within the hand. This octopus-like internal scar bound blood, lymph vessels, and nerves, causing the poor nutrition shown in Fig. 5-A.

The hand had been almost severed by a buzz-saw, following which infection developed. The tendons and nerves sloughed out, robbing the hand of all motion and sensation, except that supplied by the radial nerve.

Restoration of good function was accomplished by repair of the nerves and tendons, but the point exemplified here is the improvement in nutrition as shown in Fig. 5-B, due mainly to excision of the deep cicatrix.

year. The traction method is advisable for mild cases and for preliminary use in the more severe ones. It will place stiff joints in functionating positions, so that the patient can use the hand and thus will improve it by exercise.

In contemplating repair of the contracted hand, we should first picture in our imagination the normal hand with a clear conception of its anatomy and physiology. Only then can we perceive and calculate the defects in skin and deeper structures, nerve, lymph and blood supply, muscle balance, and nutrition. Our conception of the hand should include the range of motion of each joint and of the hand and digits as a whole, and also function from a practical standpoint. In normal muscle balance between the intrinsic muscles of the hand, long flexors, and long extensors, the hand assumes the functionating position with the wrist in dorsi-extension, proximal finger joints in flexion, and the thumb in opposition.

The creases and folds in the skin are each for the definite purpose of accommodating movements so these may be executed throughout their full range without resistance of binding or friction. The crease terminating the palm is merely a fold or plica to aid in accommodating for the one to one-half inch change of length of the palm in flexion and extension, but the two distal creases in the palm are opposite the proximal finger joints and allow for their flexion. The distal one of these is for flexion of the three fingers on the ulnar side of the hand and the more proximal one is for the three on the radial side, as these parts of the hand are often used separately. The thenar crease is to allow for opposition of the thumb. The fold assumed by the web of the thumb is fascinating, in that it may be longitudinal, oblique in one direction, oblique in the other direction, or transverse, according to the position of the thumb. Redundancy over the knuckles, the purpose of fine wrinkling of skin, the complex structure and mechanism of the inner parts, and many other points can be mentioned to make up a clear composite picture or conception of the normal hand. With this in mind we can better realize the defects and problems involved in the hand to be repaired.

Our first procedure is to furnish new skin and to correct the contracture. The structures inside the hand are liberated by substituting for the tight, binding cicatrix good, pliable skin by the use of the tubular pedicled skin graft. This results in marked improvement in the general circulation and nutrition of the hand. At this procedure sufficient of the deep cicatricial structures is excised or severed to overcome the contracture of the joints and the hand is placed on a previously prepared metal splint and the skin graft applied. Tendon grafting or repair is omitted at this skin-grafting stage for fear of infection.

Frequently the contracted joints cannot be extended at once, because the nerves have shortened. By gradual continuous extension, however, over a period of a few weeks, they will readily elongate.

The second operation is done a few months later, when the new skin will have sufficient vitality. At this time the deep structures are repaired.

FIG. 6-A

FIG. 6-B

FIG. 6-C

E.P. A shotgun discharged at close range into the volar aspect of the palm and the carpus. Infection followed. Tendons sloughed out. Flexion contracture and total disability of the hand resulted, as shown in Figs. 6-A and 6-B, which show the extremes of voluntary flexion and extension of the wrist and digits. There was no motion by any flexor tendon. The ulnar nerve and part of the median nerve were severed.

The cicatrix was excised and replaced by good pliable skin by a tubular pedicled graft from the abdomen. The deep cicatrix was also excised. The improvement in nutrition is shown in Figs. 6-E and 6-F.

Fig. 6-C shows the condition of the tendons and nerves found at operation and Fig. 6-D shows the repair of the tendons by freeing some, by placing tendon grafts in others, and by suturing the nerves.

Sensation throughout, good nutrition, excellent motion, and ability to work resulted, as shown in Figs. 6-E and 6-F.

FIG. 6-D

FIG. 6-E

FIG. 6-F

The tendons, nerves, and vessels are not only dissected out from scar tissue, but the extensive, deep, connective-tissue cicatrix, which reaches out like an octopus with all its tentacles and binds and strangles, is excised until only good tissue is left, as cicatrix in healing makes more cicatrix. By freeing the nerves from encircling scar and liberating all the deeper tissues, great improvement in the nourishment and trophic effect in the hand results.

Joints

Joint capsule if still holding in contracture should be severed or excised in its shortened part. Usually, if merely severed, the edges will rejoin. If the proximal finger joints are destroyed, serviceable joints with about seventy degrees of motion can readily be made by arthroplasty. The car-

FIG. 7-A

S.T. While this man was drawing a shotgun toward him, the charge entered the palm and forearm. Infection followed, and the flexor tendons of the palm and forearm and six inches of the median and ulnar nerves sloughed out.

Fig. 7-A shows the contracted and totally disabled hand after healing, and also the tubular pedicle of abdominal skin ready for grafting. There was no motion or sensation in the hand except from the radial nerve and the extensor tendons.

Fig. 7-B shows the condition found at operation after dissecting out the cicatricial tissue. There are wide gaps in all the flexor tendons and in the median and ulnar nerves. The pedicled skin graft was applied and later tendon grafts from the extensors of the toes and nerve grafts from the sural nerves were placed, as shown in Fig. 7-C. A pulley operation was also done, as shown, to regain opposition of the thumb.

Good function resulted, as shown in Figs. 7-D and 7-E, and the patient was able to return to work as a welder.

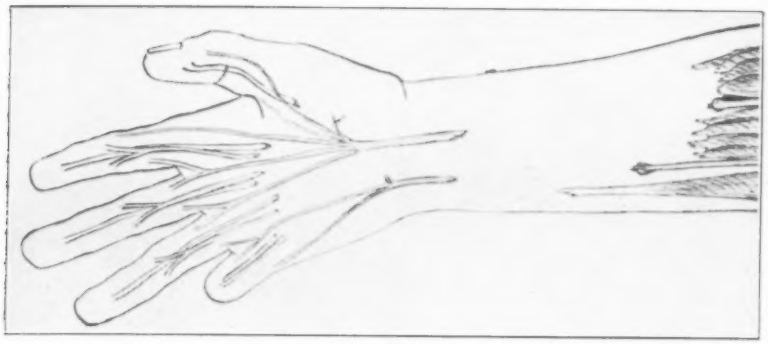

FIG. 7-B

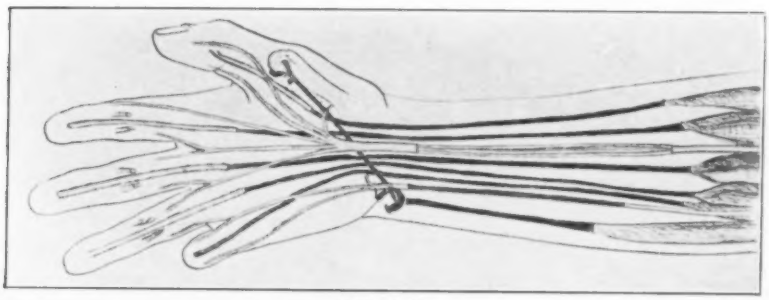

FIG. 7-C

FIG. 7-D

FIG. 7-E

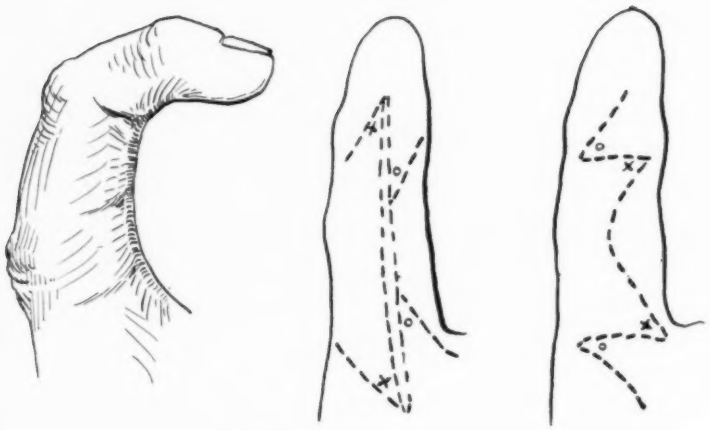

FIG. 8-A

Showing method of relieving the linear flexion contracture of a finger which results from the "pernicious median longitudinal incision". The transpositions of the flaps in the zigzag plastic are indicated by *X* and *O*.

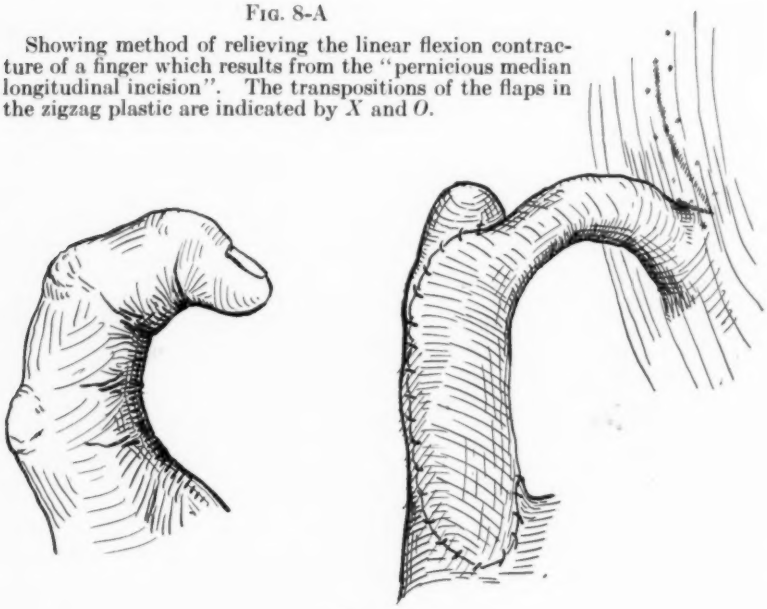

FIG. 8-B

Method of relieving a severe degree of flexion contracture of any joint by substituting for the cicatrix good pliable skin by a tubular pedicled skin graft. The borders of the skin graft should not cross flexion creases at right angles or contracting keloids will develop.

pus may have become ankylosed in poor position or may have only a small amount of painful motion. It is then advisable either to reankylose it at thirty-five degrees of dorsi-extension or to remove the proximal row of carpal bones, together with the head of the os magnum, and make an arthroplasty. The latter gives a very serviceable wrist, but is dependent on the presence of good power of dorsi-extension of the wrist by the extensor carpi radialis muscles and the extensor ulnaris. Arthrodesis in dorsi-extension

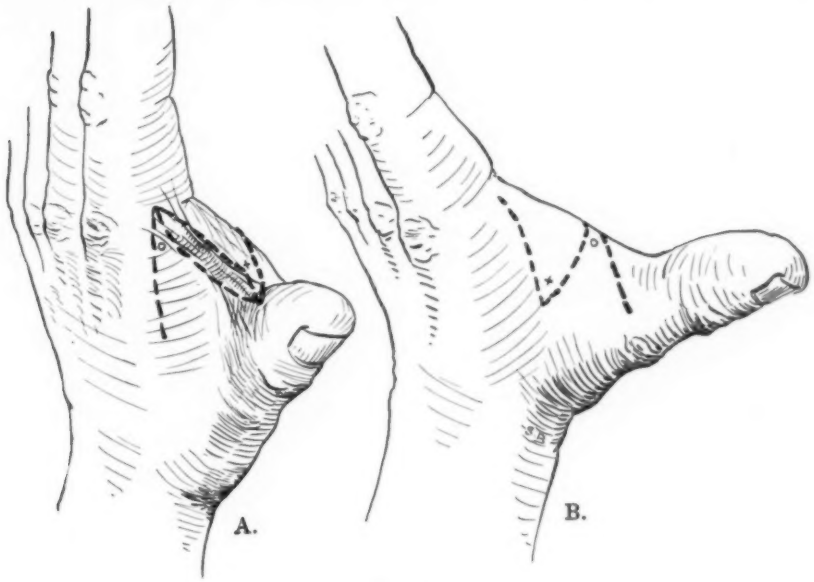

FIG. 9

Showing lines of incision in *B* and transposition of skin flaps in *A* for relieving the flexion contracture of a web.

produces very little disability and will make available five extra muscles in the forearm that may be very valuable through tendon transfer for use in moving the digits.

Stabilization of the wrist in dorsi-extension, whether it be by arthrodesis or through the action of the extensor muscles of the wrist, is absolutely essential for good grip, as otherwise the flexors of the fingers would draw the wrist also into flexion and so lose their strength.

Repair of Tendons in Contractures

Tendons reduced to scar tissue should be excised and replaced by free tendon grafts. Tendons that have been severed for several months must be repaired by tendon grafts, because the distal part of the tendon will have degenerated from disuse and the muscle will have contracted. Tendon transfers are occasionally useful. It is best not to attempt to replace the original number of tendons but instead, by making some tendons do double duty, to reduce the number of moveable parts to a minimum and to furnish sufficient soft mobile tissue between them to allow movement. Frequently it is necessary at a later operation to separate the tendons from each other and from the underlying bone by a free graft of paratenon fat taken from over the triceps tendon.

In repairing the tendons of a finger, usually the sublimis tendon is removed so as to leave but one flexor tendon, as two in a finger would adhere to each other. If, though, the sublimis tendon is cut too short at its insertion, the middle joint of the finger is apt to overextend. If cut too long the

FIG. 10-A

Showing the incorrect operation for webbed fingers. There is not sufficient skin and the linear scar down one finger and up the next is later drawn by contraction from a long *V* to a short *U*, reproducing the web and distorting the fingers in rotary and flexion contracture, as shown in Fig. 10-B.

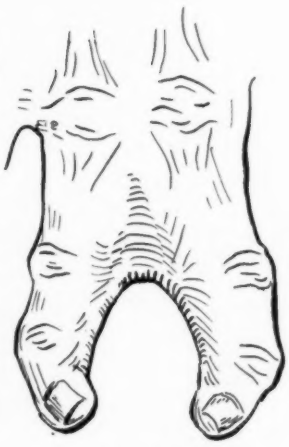

FIG. 10-B

stump of insertion will proliferate and fasten itself to the proximal segment of the finger and draw the middle joint into flexion contracture. Wherever a tendon is cut off, unless in a sheath, its unattached or unsatisfied end should be prevented from attaching itself to the surrounding tissues. This can be done by embedding its end in an adjoining tendon or by anchoring it slack, so it will not, by attaching itself under tension, hinder the movement of other tendons which are drawn by a common muscle. Occasionally after repair of tendons, the mistake is made of splinting the fingers instead of the wrist in flexion. This results in flexion contracture, as the part of each tendon repaired will attach itself to the tissues too far proximal in the limb.

Fractured phalanges and metacarpals cause much disability by holding the tendons in callus, thus causing flexion contracture of the fingers. This can usually be relieved by freeing the tendon and placing a graft of triceps paratenon between it and the bone.

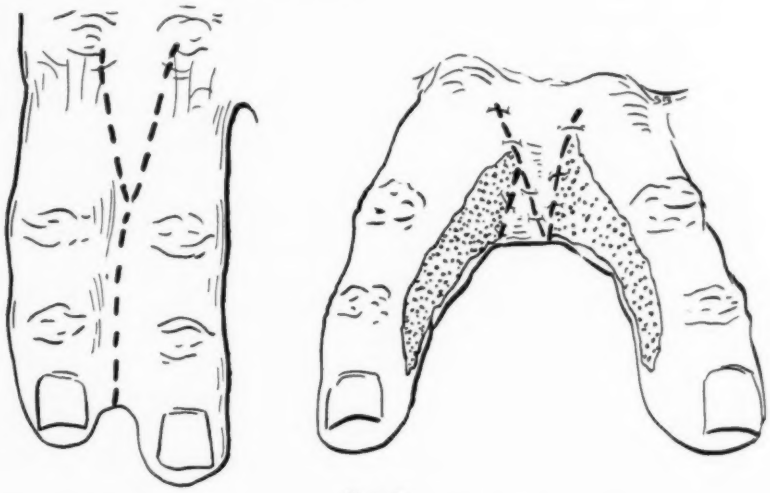

FIG. 11

Correct method of relieving a contracture between two digits or webbed fingers. The pointed skin flaps, sutured across the cleft, establish the depth of the cleft. The denuded sides of the fingers are covered by Thiersch skin grafts.

Plastic Repair of the Skin in Flexion Contractures

Injuries of limbs involve all of the tissues of the limb. We should, therefore, not specialize too closely and we must in justice to the patient be prepared to repair all of the tissues in the limb. Plastic and peripheral nerve surgery are essential.

In flexion contractures the area of skin over the contracture is too small. There is a defect of skin the size of which can be estimated by picturing in the imagination the hand in the extreme opposite position to the contracture. The minimum defect, for instance, in a strongly contracted wrist is three inches in diameter. It is usually much more, because the scar to be excised may be extensive, and also, after all scar is excised and the skin edges undermined, the surrounding skin under excess tension will contract to normal skin tension, thus causing the wound to gap more widely.

Liberation of the deep structures, by substituting for all cicatricial skin good loose, pliable skin, is essential and will greatly improve the nourishment and use of the limb.

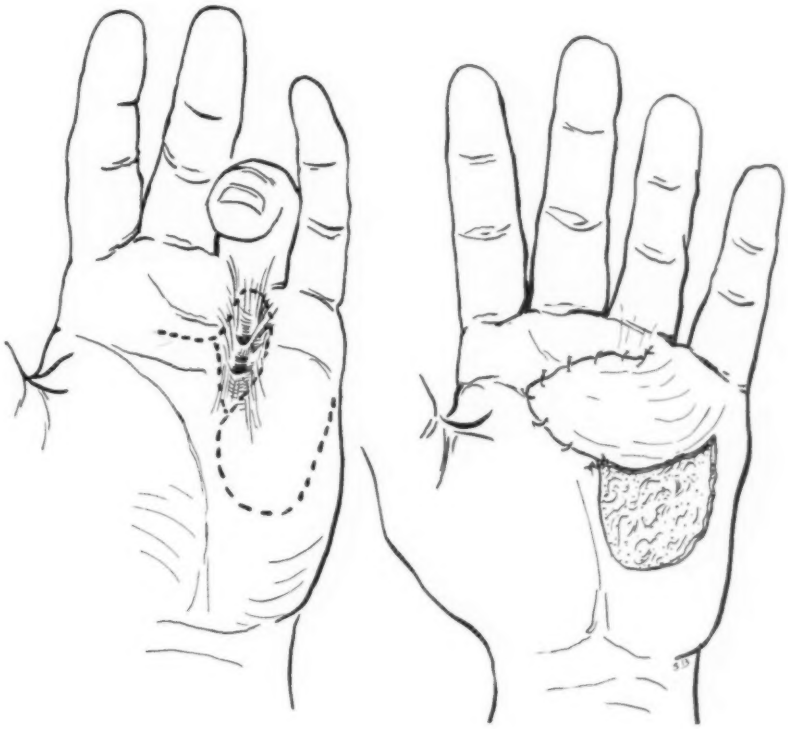

FIG. 12

Wherever there is a line of contracture, a flap of good skin may be swung across it, as a substitute for the cicatricial skin, thus breaking the line of tension. Dotted line indicates incision. The denuded area is closed by Thiersch grafting. Principle is of wide application, but example is of case of Dupuytren's contracture.

FIG. 13-A

FIG. 13-B

FIG. 13-C

FIG. 13-D

FIG. 13-E

I.W. The hand was crippled from a severe burn from an acetylene blow torch. The thumb was so adherent to the hand by cicatricial contracture that it was useless, as shown in Figs. 13-A and 13-B.

A deep cleft was made between the thumb and the hand. A flap of skin from the dorsum was used to cover the thumb and to establish the depth of the cleft, and the denuded area on the hand was covered by a whole thickness of skin graft. At the same time, by a tendon graft from the palmaris longus of the other arm, a pulley operation was done (as described in a former publication), so that the flexor ulnaris muscle would furnish power of opposition to the thumb as the thenar muscles had been destroyed. A useful, movable, and opposable thumb was the result, as shown in Figs. 13-C, 13-D and 13-E.

FIG. 14-A

FIG. 14-B

FIG. 14-C

A.M. The volar aspect of fingers and palm were destroyed by the hot rollers of a laundry mangle, resulting in flexion contracture uniting the fingers to the palm, as shown in Fig. 14-A.

Fingers were freed by scalpel, partially extended and temporarily covered by Thiersch skin grafts. Then, by slow traction, they were gradually extended. Median volar incisions were made the length of each finger and the skin was peeled back and sutured to that of each adjoining finger, everting the edges dorsally so that a continuous raw volar surface from index to little finger was produced. A pedicled skin graft from the abdomen was applied to the volar aspect of palm and digits as a whole, as shown in Fig. 14-B, and later the interdigital clefts were cut and the skin was made to cover each individual digit, as shown in Fig. 14-C.

Skin furnished by the tubular pedicle is by far the best and is necessary in contractures resulting from infection, because in these the deeper tissues are involved and the base to receive the skin graft is cicatricial, or may be of bone, tendon, or joint capsule. In areas subjected to much movement, where there are flexion creases, pedicle skin grafts are especially indicated.

Wolfe or whole thickness grafts are simpler and quicker but applicable to only superficial cicatrices with good subcutaneous tissue,—such as result from burns. Thiersch grafting gives poor skin but has many uses, as will be mentioned below.

In making Wolfe or pedicled skin grafts a few essentials in technique should be mentioned. In Wolfe or whole thickness grafting we should cut our skin the exact size of the defect to be closed by using a pattern cut in tinfoil. All subcutaneous fat should be removed and, after the graft is sewed in place, an even mild pressure by means of a rubber sponge is maintained for two weeks. It is essential to completely immobilize the hand for at least three weeks, preferably in plaster-of-Paris.

Pedicled grafts should always be tubular, because the presence of any raw surface—as with the Italian graft—renders asepsis impossible and results in broad, disfiguring scars. If all raw surfaces are eliminated, aseptic healing follows and fine line scars result. The borders of the graft should, of course, not cross flexion creases, or keloids will form. The pedicles should be liberal in length to allow ease of attachment and also to provide sufficient extra material in case some of the pedicle is lost. The pedicle is usually made on the abdomen as here much skin can be spared. The direction of the pedicle should always coincide with the lines of the natural wrinkles of the skin so that one will not leave an ugly deforming scar. The pedicles should be loose to allow free circulation, and enough fat should be trimmed away from the pedicle when opened out to allow the skin to lie flat in its new location. Tension should be that of normal skin. The hand should be immobilized on a metal splint. Tube drainage for the first twenty-four hours and mild pressure by a rubber sponge prevent hematoma. Separation in the angles of the pedicles, which is common and causes much delay, may be avoided by swinging a V-shaped flap of skin across each angle. This also prevents the suture line of the pedicle from coinciding with that of the underlying skin and so insures better healing.

Thiersch skin grafts are useful in covering over raw areas in fresh wounds to prevent infection and lessen contraction, in covering over granulating wounds to shorten infection and lessen contraction, in supplying a temporary covering of tissues between reconstructive procedures, and to cover certain areas where quality of skin is not of great importance.

If the skin on the dorsum of the hand and fingers—as from a superficial burn—becomes too tight to allow easy flexion, tension may be relieved by multiple transverse incisions. These gap widely on flexing the hand and in this position these raw spaces may be covered by Thiersch grafting.

Following extensive burns of the arm, the skin becomes, after the stage of contracture, very taut so that the arm and hand are hide-bound and

FIG. 15-A

FIG. 15-B

V.B. The hand was caught between hot rollers in a laundry mangle, denuding the skin from the whole volar aspect of all of the fingers. In the healing, each finger was drawn into sharp flexion contracture by the cicatrix which covered completely the volar surface of each.

The fingers were first united by suture to each other by everting the volar cicatrix and a tubular pedicle skin graft was applied to all the fingers and the distal part of the palm as a whole, as shown in Fig. 15-A. Later this mitten was interdigitated and the skin was laid smoothly on the full length of each finger, as shown in Fig. 15-B.

atrophic from poor nourishment. Even the skin suffers from insufficient nourishment and becomes dotted with eczema and ulceration. In such a case, if long longitudinal cuts are made through skin and deep fascia, allowing the limb to expand and the muscles to bulge, and these are closed in at once by a Thiersch skin graft, the whole limb will improve in nourishment and function. Later pedicled skin grafts can be inserted to relieve all lines of tension.

Where fingers are completely flexed and grown to the palm, the cicatrix can be cut through with a knife and the fingers partially extended. By closing in the raw surfaces by Thiersch grafts, gradual extension can be applied, drawing out the nerves and other tissues until the tubular pedicled skin graft can be used to permanently cover them.

Function and importance of flexion creases in the hand to allow movement of joints were mentioned above. It is a mistake to ever cross these at right angles by incisions, as the intermittent tension on the scar results in keloid and contracture. Such a single line of cicatricial contracture can usually be relieved by excision followed by a zigzag plastic. In this the line scar is changed to a zigzag, so that the angulation prevents tension.

Another method is to sever the scar transversely and to swing a skin flap from the adjoining skin into the gap, so as to break the line of tension. The defect left by removing the skin flap is then covered in by Thiersch grafting. This method is particularly useful in correcting Dupuytren's contracture. The skin of the palm will not stretch. The flap is taken from the ulnar aspect of the hand where in the palm there is but little movement and where a Thiersch graft will not be troublesome.

Webs between fingers or thumb can readily be relieved by a zigzag plastic. If the web is deep it is necessary to establish the depth of the cleft by placing a narrow skin flap across the bottom of the cleft. The sides of the fingers may then be Thiersch grafted. Unless this cleft-determining flap is used, the V-shaped scar down one finger and up the next will contract and reproduce the web.

In plastic work certain principles are essential. Hematoma should be avoided by hemostasis, brief tube drainage, and gentle prolonged pressure. For accurate healing, immobilization is necessary and avoidance of any raw area. Overstretching of skin results in necrosis. Skin flaps should be ample in size and with broad bases for good circulation. Skin should be undermined widely enough to prevent tension. In plastic work we should be liberal and radical as tension is fatal.

SYMPATHETIC GANGLIONECTOMY AND TRUNK RESECTION IN ARTHRITIS: INDICATIONS AND RESULTS*

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Sympathetic ganglionectomy and trunk resection result in interruption of vasomotor fibers and improved circulation. Therefore, we have employed this surgical procedure in a small group of cases of chronic arthritis in which there were vasospastic phenomena. In one portion of this group, the arthritic changes were the direct result of the vascular disturbance: for instance, the sclerodactylia in acral scleroderma, Raynaud's disease, and thrombo-angiitis obliterans in which there was spasm of the collateral arteries. These conditions have been checked in their progress, and improved by sympathetic ganglionectomy and trunk resection, but results in this type of case are not presented in this paper.

This study concerns a second portion of this group,—namely, a group of patients who suffer from cold, clammy, pale, or cyanotic extremities preceding or accompanying the arthritic changes. In our study, we investigated the condition of patients who continued to have periarticular arthritis in spite of the usually accepted forms of treatment. We knew that sympathetic ganglionectomy and trunk resection result in improved circulation, and that similar effects are obtained by application of heat; consequently, we wished to judge the results of the operative method in the light of the known results of the older method. It was obvious that operations which would affect the vascular system would not bring about change in the condition of joints that had undergone destruction or ankylosis, but it was hoped that the improved blood supply would alter the metabolism and the course of the disease. Therefore, we wished, in this study, to establish indications for sympathetic ganglionectomy and trunk resection.

In presenting the matter under consideration to a body such as this, it seems unnecessary to present a classification of arthritis, but to provide a proper background for our work we offer for your consideration the classification arranged by Hench, which, at present, is used at The Mayo Clinic. This classification is based on presumptive etiology and contains five main divisions of arthritis: (1) infectious, (2) traumatic, (3) senescent, (4) gouty, and (5) that which represents secondary arthropathy.

*Read before the American Orthopaedic Association, Memphis, Tennessee, April 18, 1931.

1. Infectious arthritis
   - Known to be of a specific infectious type, for example:
     - Tuberculous
     - Gonorrheal
     - Pneumococcic
     - Typhoid
     - Syphilitic (spirochetal, not arthropathy)
     - Staphylococcic (septic)
   - Probably of a specific infectious type (with toxins)
     - Rheumatic fever (streptococci or their toxins)
     - Arthritis with amoebic colitis (amoebic or secondary streptococci or their toxins)—rare
     - With ulcerative colitis (secondary streptococci or their toxins)—rare
     - With certain skin diseases (especially psoriasis)
   - Non-specific (chronic infectious type); streptococcic
     - Articular non-specific infectious arthritis
     - Non-articular localization (myositis, fibrositis, lumbago)
2. Traumatic arthritis
   - Extrinsic trauma (generally acute): (1) articular (traumatic, baseball fingers), and (2) non-articular (nun's knees and housemaid's knees, sprains, strains)
   - Intrinsic trauma (generally chronic): postural arthritis, static arthritis of obesity
3. Senescent arthritis
   - Chief sites:
     - Fingers (Heberden's nodes)
     - Hips (morbus coxae senilis)
     - Hypertrophic spine of the elderly; cervical frequently, lumbar most common
     - Knees (often in combination with static arthritis of obesity)
4. Gouty arthritis
   - Acute (recurring with complete remissions)
   - Chronic (progressive with residual deformity)
5. Arthropathy
   - Secondary to lesions of the central nervous system (syringomyelia, Charcot's disease)
   - Secondary to certain pulmonary conditions (pulmonary osteo-arthropathy)

Sympathetic ganglionectomy and trunk resection have been confined to the non-specific chronic infectious type of arthritis which includes atrophic, proliferative, rheumatoid, and periarticular arthritis. It has not been used in osteo-arthritis, hypertrophic, or degenerative arthritis.

As years go by diseases change in character, and some of them even almost drop out of sight, due to vigorous warfare against them, or to a not altogether explicable decline. Certainly the number of cases of acute rheumatic fever that was encountered twenty-five years ago is not seen today. Although it has not been mentioned in particular, it seems certain that the atrophic (rheumatoid, proliferative, synovial) type of arthritis seen generally in young females in early adult life is also on the wane. It is to this type that the surgical procedure under consideration especially applies. However, even in this group, certain distinct limitations must be set. Therefore, it is evident that there are only a very few out of the vast army of patients with arthritis, who throng the out-patient departments and clinics of the country searching for relief, who should be considered suitable

for this somewhat formidable surgical procedure. This will be considered more fully when selection of cases is considered. Needless to say, what we all recognize as proper conservative treatment should be used in the majority of cases before resort is had to the operation. However, in the type of case that is to be more fully described later in this paper, in which satisfactory results have been obtained, it seems to us that persistence in conservative measures, over a long period, is not only useless, but that the delay may be costly; movement of joints may be permanently restricted, due to pathologic changes in the surfaces of the joint and in the capsule. The general health must be kept at the highest possible point, all possible foci of infection must be removed, the affected parts must be treated by recognized orthopaedic and physiotherapeutic aims and methods,—such as prevention of deformities, application of heat, and so forth. Time need not be consumed here with a list of these various methods.

INDICATIONS FOR OPERATION

In order to produce vasodilatation and to increase circulation to the extremities, it is necessary to interrupt vasomotor fibers completely. Vasomotor impulses, it is supposed, originate in a subthalamic region in the brain, and follow neurones in the vicinity of the pyramidal tracts, to communicate with cells in the lateral portion of the anterior horn of the cord. From there, they are carried over white rami communicantes to the first synaptic connections in the chain of sympathetic ganglia, where they are redistributed as gray rami or postganglionic fibers. Intermingled with the vasomotor fibers are sympathetic fibers, which supply pilomotor muscles and sweat glands; thus, any surgical procedure that completely interrupts the vasomotor fibers to the arteries of the extremities will produce loss of the pilomotor reflex and cessation of sweating.

In the early work, Jaboulay and Leriche attempted to bring about vasodilatation by periarterial sympathectomy, believing that innervation was centrifugal; that is, that the fibers to the arteries followed the trunk of the vessels. Later, they suggested that the innervation probably was centripetal, operating reflexly by afferent fibers following the artery centrally. However, the investigative work of Kramer, Todd, and Potts demonstrated that vasomotor innervation of the arteries corresponded with the musculocutaneous distribution of the spinal nerve. This explained why periarterial sympathectomy failed to produce permanent vasodilatation, since the operation did not include all of the fibers to the arteries.

Royle, in attempting to relieve spastic paralysis, introduced the operation known as ramisection, a procedure which was much more effective in interrupting postganglionic rami than was periarterial sympathectomy, but which still was insufficient to interrupt completely all of the rami to an extremity, since the distribution of gray rami to the spinal nerves is not constant, and often rami are found to enter the lumbosacral nerves at some distance from the corresponding lumbar ganglion. Therefore, in developing a procedure to interrupt thoroughly these vasomotor fibers which carry

vasoconstrictor impulses to the arteries, it was necessary to bear in mind the general course of that distribution. All vasoconstrictor impulses leave the spinal cord by way of preganglionic white rami, opposite the twelve pairs of thoracic nerves and the first and second pairs of lumbar nerves. Vasomotor impulses carried upward, above the first thoracic ganglion, pass over postganglionic fibers to the cervical ganglion, to be distributed to the cervical nerves and arteries of the head, neck, and extremities. The impulses carried below the second lumbar ganglion pass over postganglionic fibers and through the lumbosacral chain of sympathetic ganglia.

In the light of our clinical investigation and experience in the treatment of peripheral vascular diseases—such as Raynaud's disease, thromboangiitis obliterans with vasomotor spasm in the collateral arteries, and the acral type of scleroderma—we have been convinced that permanent vasodilatation can be accomplished by thoroughly interrupting vasomotor fibers to the arteries of the extremities. In the lower extremities, this is accomplished by performing bilateral lumbar ganglionectomy and trunk resection, including the second, third, and fourth lumbar ganglia, and the intervening trunk on each side. If the surgeon were positive that he had divided the sympathetic trunk and all stray rami below the second lumbar ganglion, it would be unnecessary to remove the lumbar ganglion and trunk, but since serious sequelae do not arise from the procedure employed, we believe it is better to err on the side of safety, in removing more of the ganglionic trunks than necessary, than to leave stray fibers and fail to produce complete vasodilatation. The procedure employed in producing vasodilatation in the arteries of the upper extremities consists in resecting the upper portion of the thoracic trunk, with complete removal of the lower cervical and first thoracic ganglia. In order to assure against ascending, stray, gray rami entering the brachial plexus, thorough dissection is made of the lower trunk of the brachial plexus, and all communicating rami or nerve branches to the lower cervical and first thoracic nerves are interrupted. Any stray fibers that are mesial to the thoracic trunk are likewise interrupted. The thoracic procedure has not been so universally successful as lumbar ganglionectomy. In the occasional case, small sweating areas on the hand or arm have been observed following cervicothoracic ganglionectomy, which means, of course, that in spite of this rather extensive procedure a few fibers were still finding their way to the cervical nerves. It is possible that these may ascend through the cardiac plexus.

CLINICAL APPLICATION

Following the results of sympathetic ganglionectomy and trunk resection in Raynaud's disease, Rowntree, in collaboration with Hench, suggested that lumbar ganglionectomy and trunk resection, as employed by Adson, be tried as an experiment in a case of periarticular arthritis of the chronic type. This case and others have been reported by Rowntree and Adson. The arthritis in the case mentioned involved not only the feet, ankles, and

knees, but also the hands, wrists, elbows, and shoulders. Cervicothoracic ganglionectomy by the posterior approach had not been developed at that time, but lumbar ganglionectomy was advised and employed with satisfactory results. The first patient was operated on in June, 1926. In addition to rheumatoid, chronic, atrophic, arthritic symptoms, she presented distinct vasomotor disturbance, complaining of cold, clammy, pale, and occasionally cyanotic extremities. The vasomotor symptoms were relieved immediately by sympathetic ganglionectomy. The skin over the feet and legs became warm, dry, and pink; the pain subsided gradually; the swelling became reduced; the muscles again became fusiform, and the range of motion and the function improved. This experience led to the search for similar cases. It was apparent that this group was rather small when compared with the large number of patients with arthritis who came to the clinic; often ankylosis and destruction of one or more joints had taken place by the time the patient arrived for treatment. It was obvious that improvement in circulation would not alter the ankylosis, but the procedure was employed in some of the extreme cases for its influence in checking the arthritic process or relieving pain in the more advanced cases.

In view of our experience in the treatment of peripheral vascular disease, we applied, in the selection of cases, the same vascular index that we already knew, limiting our selection to patients with non-destructive periarticular changes. In all of these cases the disease was of the chronic type, and the patients previously had received the usual forms of treatment, consisting of eradication of foci of infection, dietary measures, and physiotherapy, with only temporary relief from application of heat.

VASCULAR STUDIES

The vascular studies employed were those outlined by Brown for selection of operative cases of Raynaud's disease and other peripheral vascular diseases. The study was based on changes in cutaneous temperature resulting from administration of foreign protein. It had been known, for some time, that administration of protein in the form of triple typhoid vaccine produced increased cutaneous temperatures in the regions of distribution of non-occluded arteries; the increases were several degrees higher than the increase in mouth temperature. These differences in temperature were the result of inhibition of vasomotor responses by the heat-regulating apparatus, in order to permit more blood to flow to the surface and thus to lower the body temperature, which had risen because of the increased metabolism induced by administration of foreign protein. Brown utilized this principle in developing an index for determining the degree of vascular spasm by measuring the temperature of the mouth and of the skin, before and during the height of the fever. This was accomplished by taking the mouth temperature with a clinical centigrade thermometer, and the temperature of the skin by the electrothermocouple, also graduated in degrees centigrade. Inasmuch as the changes in temperature of the skin of the hands and feet were dependent on patent and elastic arteries and arterioles, Brown

stated that unless the increase in temperature of the skin was two or more times the increase in oral temperature, little was to be accomplished by sympathetic ganglionectomy and trunk resection. This arbitrary rule has been verified many times by postoperative results. It has been of great value in selecting patients for operation. We have found that it offers material assistance in the proper selection of patients with arthritis for sympathetic ganglionectomy. However, it is not infallible, and there have been a few patients with a high vascular index who failed to respond to sympathetic ganglionectomy and trunk resection. It is not safe always to infer that increased cutaneous temperature is going to result in increased circulation to the joints, for it is possible to have associated thrombosis of arterioles in the vicinity of the joints, just as thrombotic processes and vasomotor spasm are found in the group of patients with thrombo-angiitis obliterans.

IMMEDIATE EFFECTS OF OPERATION

Immediately following operation, the skin over the extremities becomes warm, pink, and dry, giving evidence of the vasomotor fibers having been interrupted, as well as those leading to the sweat glands. For five or six days the skin remains flushed; then it subsides to normal color, but if examination is made of the capillary loops after that period, and if their condition is compared with that before operation, it will be observed that the flow of blood, as indicated by movement of the corpuscles, has been distinctly increased. The pain and swelling become gradually less, and continue to decrease while the patient is in bed, at rest; on movement of the joints or use of the extremity, the symptoms may temporarily reappear, but subside gradually. Very often, patients overdo during their convalescence, because they feel so comfortable when at rest, and are prone to become discouraged in the first six months following operation. To obviate this feature, Rowntree urged graduated light exercise and physiotherapy, to avoid undue trauma during this period of restoration. Some patients do not experience as much discomfort as others, and progress slowly from the onset, but the usual course is for a patient to experience marked relief immediately following operation, then for pain and soreness partially to return for three or four months, and finally for gradual and permanent recovery from pain, tenderness, and swelling of the extremities to supervene. The mobility and the return of function continued parallel with the reduction in pain and swelling and the development of muscular function.

OPERATIVE SEQUELAE

To date, in a series of forty-one patients operated on, there has not been a death. None of the patients has complained of a sensation of excessive heat from increased circulation. Dryness of the skin persists, but apparently fails to be an annoyance. In case it should be annoying, daily application of lanolin, or cocoanut oil, would relieve any itching sensations that might arise. In lumbar ganglionectomy and trunk resection some of the presacral fibers are sectioned; hence the impulses to the internal sphinc-

ters of the bladder and rectum, and the inhibitory impulses to the detrusor muscle of the bladder and sigmoid have been reduced, but not to the extent of giving rise to discomfort. As a matter of fact, sectioning of the presacral fibers has been performed to relieve cord bladder and megacolon. The Horner's syndrome, which accompanies cervicothoracic sympathetic ganglionectomy and trunk resection, is neither conspicuous nor troublesome, if equal on both sides. The unilateral Horner's syndrome is most disfiguring, since the contracted pupil and the dropping lid are obvious to the casual observer. Accompanying the ocular phenomena is dilatation of the retinal arteries and veins. These phenomena indicate that vasomotor fibers have been sectioned, and that the arteries and veins actually have been dilated. According to Wagener, who has made preoperative and postoperative measurements, the vessels increase in diameter from a third to a half their preoperative size. He stated, also, that repeated examination of these patients shows that the vasodilatation persists. Muscular pains develop frequently following the sympathetic operation. They appear to become aggravated by massage and passive motion and are described by the patient as "aching pain", and disappear gradually as the muscle returns to normal size and takes on its normal function. The explanation of this phenomenon has not been determined definitely, but we believe it to be due, probably, to engorgement with blood and stretching of the muscle fibers during the regenerative stage. In one case, brachial symptoms, weakness, and paraesthesia developed during operation as the result of pressure while the patient was in a Trendelenburg position. Infections of wounds have occurred, but are no more frequent than in laparotomy or thoracic operations generally. Postoperative ileus likewise has occurred following lumbar ganglionectomy, but again is no more frequent than is observed in extensive laparotomy.

Tables I and II contain data on the types of cases in which operation was performed, and on the results obtained. Group 1 represents the cases in which the disease was most advanced, and in which there were numerous ankylosed joints in which sympathectomy is of no value. Group 2 repre-

TABLE I

TYPES OF CASES IN WHICH OPERATION WAS PERFORMED

Group	Cases*	General results	Average			
			Age at onset, years	Duration of symptoms, months	Vascular index (G. E. Brown)	Increase in cutaneous temperature, degrees C
1	6	Failure	28	92	6.9	9
2	11	Slight (30 per cent.) improvement	29	76	4.4	7
3	20	Marked (70 per cent.) improvement	21	58	4.9	7.6

*In four of the forty-one cases studied, operations were performed too recently to be included in the table; the patients were still in the hospital at the time this paper was written.

TABLE II

RESULTS OF SYMPATHETIC GANGLIONECTOMY AND TRUNK RESECTION FOR CHRONIC ARTHRITIS (FAILURES OMITTED)

Average degree of:	GROUP 2* (11 cases) Slight improvement	GROUP 3** (10 cases) Marked improvement
General improvement, per cent.	20 to 30	70
Relief of pain, per cent.	34	75
Reduction in swelling, per cent.	32	67
Increase in motion, per cent.	17	64
Decrease in deformity, per cent.	8	54
Improvement in function, per cent.	7	70
Improvement in walking, per cent.	11	70
Degree of ability to carry on regular work, per cent.	..	74

*Arthritis progressed, in extremities for condition of which operation was not done, in five cases and remained stationary in three, and did not develop in three.

**Arthritis progressed, in extremities for condition of which operation was not done, in six cases, remained stationary in two, and improved in two.

sents the border-line cases, in which sympathetic ganglionectomy and trunk resection may be justified in the hope of reducing the pain and checking the disease. Group 3 represents the cases in which sympathetic ganglionectomy and trunk resection has produced satisfactory results and is indicated because previous, more conservative treatment has failed. In these cases, the operation affords real relief from symptoms, checking the arthritic process. Some extremely brilliant results were obtained in this group of patients, and to emphasize the clinical picture of the properly selected case a detailed report of one case is included. It illustrates the course of the disease, the types of treatment received, and the results obtained from sympathetic ganglionectomy and trunk resection. The report was written by the patient April 1, 1931. She was first admitted to The Mayo Clinic, September 21, 1925, at the age of twenty years, complaining of diffuse chronic arthritis.

REPORT OF A CASE

"When I was about fifteen years of age, I began to have aching pains in my feet. At first these pains occurred whenever I walked, but later were present most of the time. The first doctor I consulted treated me for fallen arches and weak ankles and had special shoes made for me, which gave no relief. The wrists then began to swell and became painful. The swelling disappeared but stiffness and pain remained. During this period of months I consulted numerous doctors and tried various treatments without improvement. I also lost considerable weight and became exhausted and fatigued on the slightest exertion. My tonsils were removed and supposedly infected teeth were extracted. I was ordered to bed and given diets rich in cream and butter, and later tried a fruit diet. I received electric treatment and baking treatment and massage, with little or no value. I then consulted another physician who prescribed quantities of drugs which did appear temporarily to improve my condition to such an extent that I was able to take on college work. While the arthritis seemed to be temporarily checked, at times it was very

troublesome. It had spread to all my joints except those of the spine. My fingers, wrists, and elbows were stiff and motion had been distinctly impaired.

"After continuing college interruptedly for three years, I became worse and had to discontinue school. It was then that I consulted the staff of The Mayo Clinic at St. Mary's Hospital where I was given examination after examination in the hope of locating some source of infection. None was found. I was given physiotherapy, daily, and took typhoid vaccine weekly in regular courses of five or six treatments. These treatments at first appeared to help me, but again failed and my symptoms continued. About a year later I did improve sufficiently so that I was able to continue my college work, graduate, and began to teach, when I developed symptoms of chronic appendicitis. This I was told was the probable source of my infection and therefore had an appendectomy. Following this I did improve for a time and began to teach again, when my arthritic symptoms flared up and aggravated the numerous painful joints.

"Again I consulted The Mayo Clinic staff and was placed on various diets, rest, and physiotherapy. I now found that I was tired all the time and that it was almost impossible for me to bend or move at all. It was following this attack that special vascular studies were made and sympathectomy was discussed. My hands and feet had always perspired a great deal and were always cold and clammy, but before accepting the operation I was advised to try some colon irrigations, which were of no value. My knees, hands, wrists, elbows, and neck were then treated with x-rays for six months, but in spite of this my symptoms grew worse and I was glad to try any sort of operation with the hope of getting some relief, and submitted to cervicothoracic sympathectomy by Dr. Adson December 20, 1929. Immediately following the operation, my hands became warm and dry, and to my surprise the pain in my arms and hands had gone. Since then, during the sixteen months' period, the pain has not returned and the movement of my hands and arms has increased so that I am able to use them and I have been able to carry on my school work. The muscles of the hands and arms have increased in size and strength, but the deformity of the joints and the ulnar deflection have not changed.

"Five months following the operation for the upper extremities, I submitted to lumbar sympathectomy and have received equally good results. The skin over my feet and legs has become warm and dry; the swelling and pain have disappeared, and only twice have I experienced any pain in my knees. I returned to my position of teaching last September and have continued to teach every day. My general physical health has improved also, so that at present no one would know that I had ever been ill."

SUMMARY

It is apparent that there is a group of cases of chronic arthritis in which vasospastic phenomena are seen and are responsible for or aggravate the arthritic symptoms. Sympathetic ganglionectomy and trunk resection offer additional aid in the treatment of these patients, but extreme care should be exercised in the selection of cases. Sympathetic ganglionectomy and trunk resection is indicated for young persons, who have vasomotor phenomena, such as cold, wet, pale, or cyanotic extremities, but whose arteries are patent, elastic, and not occluded. The operation is not indicated in advanced cases, in which there is marked ankylosis; neither is it indicated when the infectious process is still present. The operation affords the greatest amount of relief in the smaller joints of the extremities,—fingers, hands, wrists, toes, feet and ankles. When there is involvement of the larger joints—such as the knees, hips, shoulders, and spinal column—little is accomplished either in checking the disease or in ameliorating the symptoms.

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TREATMENT OF VASCULAR DISEASES OF THE EXTREMITIES BY SYMPATHECTOMY*

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RAYNAUD'S DISEASE

Claude Bernard[1] demonstrated the fact that the vasoconstrictors, controlling the vessels of the extremities, arose in the sympathetic system. His work was, of course, on lower animals and done for experimental purposes.

Raynaud[2] published his first papers in 1862, and writes of his first case as local syncope of the most simple form. He describes this as a momentary absence of local circulation. In his Case 3 he describes the condition as due to a spasmodic state of the radial and ulnar arteries. Autopsy findings of a patient, who for years had had typical symptoms of local syncope, revealed no abnormalities of the arteries. Raynaud was aware of the experiments that had been done wherein the fact was established that section of the sympathetic system raised the surface temperature of the part. He listened to heated discussions as to the explanation of the phenomenon of the increase in local heat.

He, therefore, finally considered that local syncope was due to spasm of the arterioles and that there was no pathological change to be found in the vessel. Ergot did not produce the condition. The treatment he recommended had nothing unusual or of a specific nature, except perhaps the belief that galvanism was of distinct value. It was applied over the spine. Strangely enough, Raynaud does not note or remark upon an outstanding symptom,—*viz.*, sweating and moisture of the extremity.

In the second publication by Raynaud he was able, in a typical case of disease, to study changes in the eyes, and he found that, during an acute attack, at the time the extremities were cyanotic, there were definite changes in vision that alternated with the attacks,—spasm in the retinal arteries together with an abnormal pulsation of the veins. Hemiplegias were noted in cases of this type, but surely they must be of a transient nature to be included in this group,—the product of vasospasm.

Raynaud's disease is therefore the ideal condition for treatment by sympathectomy. We now know by clinical experience, as well as by animal experiments, that one may with impunity interfere with sections of the ganglionic system without dire results accruing to the patient (Cannon[3]). That the present phase of surgery of the sympathetic nervous system owes its inception to the work of Royle[4] is obvious. In his first case of lumbar ramisection he observed changes in the temperature of the limb on the same

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side as the operation. These changes were assumed to be due to increased blood supply. Other factors enter into the question of increase in temperature. Instruments of precision are now to be had which will give accurate surface temperature readings. Surface temperature is dependent also upon the surrounding air temperature, in that cold air will stimulate the vasoconstrictors in the normal limb, leaving the treated limb with its peak load of blood in the vessels. The normal limb will, therefore, be much colder than the other. The difference may be seven or eight degrees centigrade.

Another factor of decided moment in the explanation of temperature readings is the change in the moisture of the skin of the extremity. The sweat glands are supplied by the sympathetic nerves and as these are overactive in Raynaud's disease, the extremities are moist and there is consequently a great loss of heat by evaporation. More heat is lost from a moist foot than from a dry one.

Prof. Burton, of the Department of Physics of the University of Toronto, has recently constructed an instrument with which we have been estimating the moisture of skin. It is very accurate apparently and the evaporation records show an extraordinary difference before and after sympathectomy and between limbs that have lost their sympathetic control and those that have maintained it.

To my mind the outstanding objective feature of a limb, following sympathectomy, is the dryness of the skin. Stroking the normal skin and the skin of an involved limb shows a marked difference. This difference is present also at the level of anaesthesia in patients who have spinal anaesthesia. Advanced cases of Raynaud's disease are very rare and the acute phase is apparently a rapidly progressive one.

The following is a description of a typical case of Raynaud's disease.

M.B. White female, twenty-nine years of age.

From the time she was a small child she suffered from cold, clammy hands. When she was twenty-two years of age, her tonsils were removed. She was well and employed as a stenographer and carried on regularly at this occupation. In the summer of 1929 she observed that she was becoming constipated and that she required an aperient daily. In addition, later on, it became necessary to take an enema every other day. She noticed in August 1930, that washing her hands in cold water left them mottled, cold, and numb. On September 28 she wakened to find that her hands, feet, face, and whole body were swollen. She was in bed for a week or so, during which time she suffered from stiffness and pain in her hands and feet. Following this acute phase, she found that the symptoms that involved her hands were more marked. The stiffness became such that she found it difficult to make a fist. The fingers appeared dark and congested, more specially marked in cold. Her fingers were so tender that she found it impossible to type with certain fingers. Medical and palliative treatment had no effect on the condition and she was referred for surgical treatment on December 1, at which time she was complaining bitterly of tenderness, stiffness, and discoloration of the fingers and toes. The fingers showed a marked loss of the pulp at the ends. The hands were clammy and cold, and on the first and second fingers of the right hand were small flat areas which resembled dry gangrene. The left hand showed a similar involvement with the exception of the little finger and the ulnar side of the ring finger. This area appeared normal in color and was not so tender as the other areas. Her radial pulse, while small, was palpable. Her feet were mottled in appearance, having dark red patches, and were cold and moist to the

touch, and she said were stiff and painful. Her general condition was wretched. She suffered almost constantly from headache. Her constipation was marked and resisted treatment. Her metabolic rate was undisturbed; her pulse rate ninety-three, and blood pressure: systolic, ninety-four; diastolic, fifty-two.

On December 4 she was prepared for operation, and an operation used by Adson[5] and originally devised by Henry[6] was performed. Briefly it was as follows: A mid-line incision was made from the tip of the sixth cervical vertebra to the fourth dorsal. Subcutaneous tissue was divided and retracted to the right side. An incision was made through the aponeurosis of the attachment of the rhomboid and trapezius. This incision was carried down through the spinal muscles until the tip of the transverse process of the second dorsal vertebra was felt. The transverse process was cleared subperiosteally of all attachments and a chisel divided it from the vertebra. This being removed, the neck of the second rib was exposed. Periosteal dissection was made of the second rib out as far as the angle. At the angle it was divided with a pair of biting forceps. A sharp instrument was then used to divide the ligaments of the head, and the neck and head were removed. A small opening was made at the internal end of the wound through the periosteum, from which the rib had been removed, and the finger, exploring gently, was able to push downwards and forwards the parietal pleura and the apex of the lung. This was pushed back until there was a cavity about the size of a walnut. Crossing the mesial end of the quadrilateral space was to be seen a cord. On dissection of this one could, without difficulty, identify the second thoracic ganglion with its gray ramus going to the second thoracic nerve and the thoracic cord running upwards to disappear under the first rib. Dividing the thoracic trunk just below the second thoracic ganglion and freeing the ramus from the second thoracic ganglion, it was found that gentle traction brought into view, from under the first rib, the lower extremity of the first thoracic ganglion,—that is the lower part of the stellate ganglion. Gentle dissection with the fingers and the blunt hook mobilized this, so that it could be brought into the quadrilateral opening where the different rami from it were pulled off by blunt dissection and the entire ganglion was visualized as well as the cervical cord going upwards to the middle cervical ganglion. The cord above the stellate ganglion was divided. The same procedure was followed on the opposite side. The wound was closed in the usual fashion, except that the skin was closed with subcutaneous No. 0 catgut stitch.

This operation was selected, because of the possibility of doing both sides through one opening and having the wound in the back, which would be a consideration in the case of a female.

Following the operation her condition was excellent and showed no shock. It was noted by observers that on reaching her ward, her hands were normal in appearance. When she became conscious she stated that her first conscious act was to make a fist, which delighted her inasmuch as she had been unable to do this for a long time previously. Within an hour of her operation her hands were warm and dry and normal in appearance. When she became *compos mentis*, she declared that her pain and stiffness were gone; and for the first time in her life her hands felt warm, dry, and comfortable. She stated that she was conscious of a heaviness to her eyebrows and eyelids. There was no obvious change in the general appearance of her face. Her pupils were inactive to change on pinching of the skin of the neck, but reacted to light and, to a much less degree, to distance. She was not conscious of any further change in the face, eyes, and neck. On December 7 she began to complain of pain in each shoulder girdle and up the back of her neck. This pain was troublesome and she described it as neuritis. It had entirely disappeared on December 12.

The excision of the ganglia in the lower cervical and upper thoracic region had temporarily upset the function of the lumbar ganglia, as for two days following her operation her lower extremities were warm and dry and normal in action. They soon returned to their state prior to the operation.

On December 13 she was again taken to the operating room and a sympathectomy of her lumbar ganglia was done on each side, following the approach described by Royle.

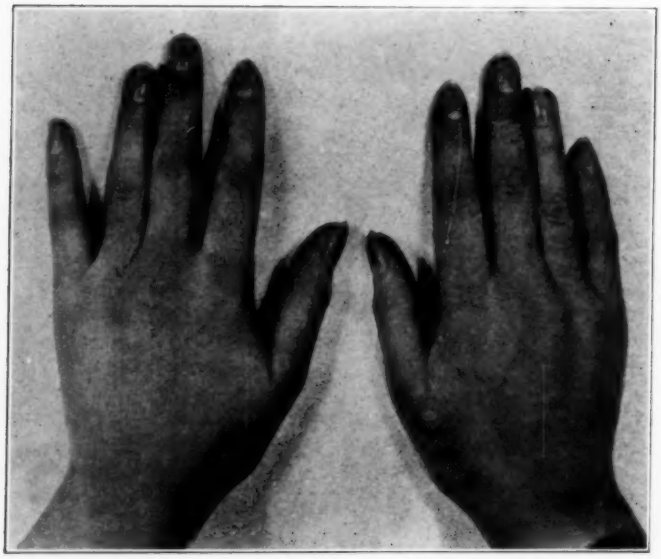

FIG. 1

The hands before operation, showing the congestion and cyanosis of the hands and fingers, especially the tips.

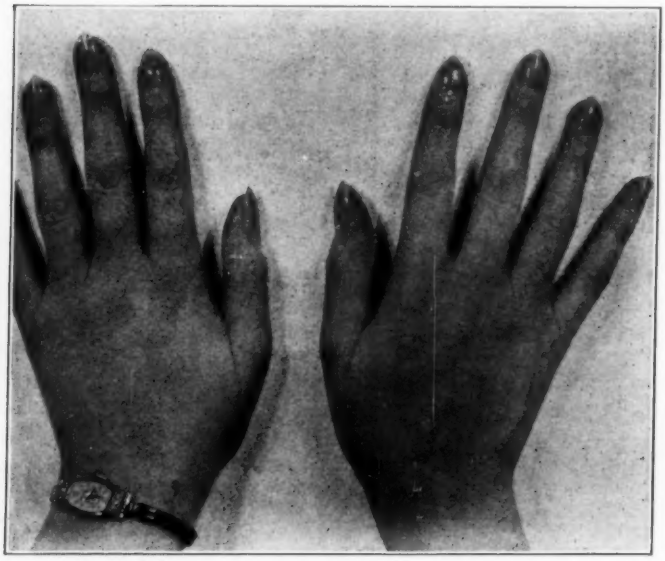

FIG. 2

After operation. Cyanosis is seen to have disappeared and hands are normal in color.

On the return to her ward her feet were found to be normal in color and the warmth increasing. As she became conscious she found that her legs were dry, warm, and comfortable. The temperature reading of her arms and legs was taken before and after operation by an electric apparatus devised by Prof. Burton. The temperature changes were those characteristic of a sympathectomy.

Pathological report of the ganglia excised was as follows:

December 4. Diagnosis: Stellate ganglia with chronic inflammation.

The gross specimen consists of the right and left stellate ganglia, measuring approximately one and five-tenths by one by seven-tenths centimeters. They are grayish-pink in color, rather firm in consistency, and their cut surfaces are of a glistening, compact, whitish appearance.

Microscopically, sections of ganglia show them to be made up of many large ganglion cells supported by neuroglial fibers. Throughout, there is a slight lymphocytic infiltration. This lymphocytic infiltration is more marked in the right ganglia than in the left.

December 15. Diagnosis: Non-medullated nerve and ganglion.

The gross specimen consists of lumbar sympathetic trunk from the right and left sides. They measure approximately the same, being two and five-tenths centimeters in length by four-tenths of a centimeter in thickness. They are grayish-pink in color, soft in consistency, and present two small dilatations along their course.

Microscopically, sections from both sides show them to be made up of non-medullated nerve fibers and ganglion. The ganglion is made up of bundles of nerve fibers interspersed about which are a large number of ganglion cells.

On March 4, 1931, she reported that constipation had entirely disappeared. She takes a small quantity of liquid paraffin daily and this is ample to produce daily movements. The headache she has not had on a single occasion since the operation on December 4, 1930, when the stellate ganglia were removed. Her Horner's syndrome is not obvious objectively and barely subjectively. Electrocardiagram: normal. Blood pressure: systolic, ninety-eight; diastolic, sixty-four. Pulse: seventy-two at rest.

In this case rate response to exercise and response to respiration (sinus arrhythemia) are not altered by break of sympathetic.

DISCUSSION

This patient had suffered from cold hands and feet as long as she could remember. Constipation appeared in the summer of 1929 and became troublesome in the summer of 1930. The fingers were noticed to be mottled after using cold water. An acute phase appeared on September 28, 1930, following which the condition of her extremities became worse, so that when she was seen on December 1, 1930, she had some patches of dry gangrene on the tips of her fingers. Excision of her stellate ganglion on each side, as well as the lumbar ganglia, improved immediately the circulation in the hands and feet so that it appeared more than normal. Subjectively the hands and feet were more comfortable than they had ever been. The function of the sweat glands was so diminished that the limbs were no longer moist but became dry. Our experience in lumbar ganglionectomy would warrant us in definitely stating that this woman's constipation would be absolutely cured, as the subsequent events have proved. She has no focus of chronic infection that we can locate. The whole picture is one of involvement of the sympathetic system and hyperactivity, causing vascular disease and involvement of her smooth muscle control of the intestines.

THROMBO-ANGIITIS OBLITERANS

The pathology underlying this condition is entirely different from Raynaud's disease. Many excellent descriptions of the symptoms and pathology in this condition are available, one of which is "Thrombo-angiitis Obliterans" by Brown, Allen and Mahorner[7]. The disease is one that has been known for centuries but which has been classified comparatively recently (Buerger[8]). The symptoms of this disease are clear-cut, and its diagnosis presents no difficulties, nor is the outcome of the disease dreadful in all cases, as was formerly believed. Some cases have symptoms of a very mild nature over many years. Some have marked symptoms and gangrene of a fairly extensive nature and then have years during which they are free from symptoms. Some observers believe that tobacco is an etological factor, and recently I saw a patient who had had six amputations of fingers, toes, and one leg, who suddenly became free of symptoms when he stopped smoking, a habit to which he had been heavily addicted. After ten years' freedom from symptoms he again resumed his use of tobacco for the period of one month. Symptoms promptly returned, and disappeared with the discontinuance of tobacco.

In spite of the fact that there is a mechanical block of the vessels by proliferation of cells and organization of clot, there is present in clinical cases a large element of vessel spasm, as is amply evidenced by the work of Brown, with his protein test. Temperature increase occurs in spinal anaesthesia and temperature increase and relief of pain and symptoms are produced by infiltration of the lumbar and cervical sympathetics by novocain and alcohol, also by the infiltration of peripheral nerves by anaesthetic as is being done by Morton and Scott.

Some of these methods have been and are being used to determine which cases show a large element of spasm, as such cases are suitable for sympathectomy.

The varying severity of the condition in different cases makes it difficult to apprise any form of treatment. The estimation by a precise method of the element of vasospasm in any particular case is of value, but it is probably true that every case of thrombo-angiitis obliterans has some degree of spasm, and this spasm can be relieved by sympathectomy. Recently a patient recovered pulsation in the dorsalis pedis immediately after operation. If this operation is done empirically the experience will doubtless be that every case will derive some benefit. We have not had a single patient who did not feel greatly improved, following operation. Pain is relieved without exception, wholly, or in part. Temperature of the foot is increased, and local amputations may be undertaken, with impunity. The hope that an ulcer may be cured by this surgical proceeding alone is vain. That sympathectomy may be a factor in arresting the disease is unknown, but that it is of distinct value in a case of threatening gangrene can be answered in the affirmative. I have yet to see a patient who, having had the experience of an operation, did not give favorable evidence.

The worst case of thrombo-angiitis obliterans is evidently the case that has an obvious degree of superficial phlebitis. Cases of this type show a very slight improvement, if any, following sympathectomy.

ARTERIOSCLEROSIS

This condition, like thrombo-angiitis obliterans, is one where there is a definite pathological change in the vessel wall, but unlike thrombo-angiitis obliterans has not the tendency to the formation of an adequate compensatory circulation. It is universally more progressive. In those cases associated with diabetes, the condition is more serious. Sympathectomy in impending gangrene from arteriosclerosis, or in cases where there are the symptoms of ischaemia—such as claudication, numbness, and pain in extremities—has a very definite place and is of decided advantage. A man of seventy with general arteriosclerosis developed symptoms of ischaemia in his legs. His numbness was marked, but the pain in his feet was such that he was bed-ridden and unable to sleep without the aid of morphia. His feet were cold and moist, dorsalis pedis and post-tibial arteries were pulseless on palpation. A double lumbar sympathectomy was performed in September 1930. Following the operation he said his feet were comfortable. They felt warm and dry. These last two features were easy of clinical confirmation. At the present time, six full months after operation, his condition is as follows: He is up and about. He has some numbness persisting. The feet are subjectively and objectively still warm and dry. The post-tibial is palpably pulsating at the left ankle and he has required no drug for pain since his operation.

Our experience with this condition complicated by diabetes is not so happy. We have had no early cases, but in those advanced cases, where gangrene was already present and in a moist or infected form, pain has been diminished but the ulceration has not been cured. One would, however, feel that early interference with the sympathetic trunks would, in combination with insulin, be sufficient to relieve the vasoconstriction in the diseased vessel, and thus increase the blood supply to such an extent that gangrene might be altogether prevented and any early infection might be defeated. It is certain that if no other benefits accrue, the comfort of the patient will be materially increased. It is possible also that, following sympathectomy or associated with it, more conservative amputations may be done.

CONCLUSIONS

1. In Raynaud's disease sympathectomy will relieve the symptoms of the disease and prevent the formation of gangrene.

2. All cases of vascular diseases of the extremities have associated vasospasm in a varying degree. This latter can be relieved by sympathectomy.

3. Sympathectomy leaves no important deleterious effects either in the lumbar or cervicothoracic excisions.

4. Lumbar sympathectomies improve the bowel action.

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ADVANTAGES OF OPERATIVE TREATMENT OF FRACTURES OF THE ELBOW

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Because of the frequency of fracture of the elbow, it is wise to place emphasis on certain special points in regard to the effect of trauma in the treatment, for, because of the importance of the perfect function of this joint, favorable conditions for its cure are most essential. In considering the subject, we have used the term "elbow fracture" in order to place these fractures in a group which includes injury to all the bones of this joint. From a study of the records of the Juárez Hospital, it is found that,

FIG. 1

Case 1. S. L. Fracture of condylar type.

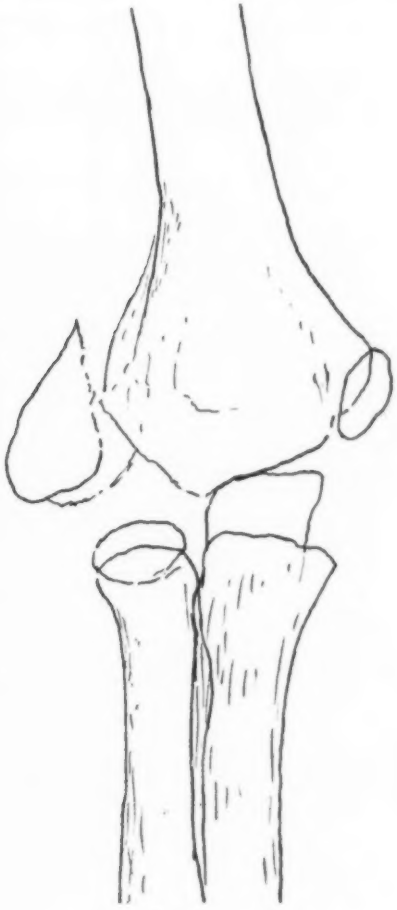

FIG. 2

Tracing of x-ray shown in Fig. 1.

next to fractures of the leg (femur, tibia and fibula) and the clavicle, fractures of the elbow are most frequent. Of the fractures of the elbow, the larger number are fractures of the lower end of the humerus and it frequently occurs that when one of the lower bones is fractured, the other is dislocated. These fractures occur most frequently in children and adolescents, occasionally in adults, and very seldom in older people.

In making an accurate diagnosis, it must be remembered that the muscles play an important rôle and must be considered in differentiating between dislocation, fracture, or contusion. Valuable data can be obtained by careful observation of the appearance, shape, volume, etc., and also of the ecchymosis, which in a fracture is invaluable datum, sufficient in itself, we believe, to furnish evidence of fracture within the joint when it is extensive and appears late and near to the joint, whether it be the shoulder, elbow, knee, or ankle. The use of the x-ray is always necessary.

Especially in elbow-joint fractures, is it necessary to bear in mind the three therapeutic principles in the treatment of fractures: first, the best pos-

FIG. 3
Case 1. S. L. Lateral view.

FIG. 4
Tracing of x-ray shown in Fig. 3.

FIG. 5

Case 1. S. L. After operation, showing prostheses consisting of a screw and a wire lap attaching the condylar fragment to the humeral fragment and a second wire lap holding the olecranon in place.

FIG. 6

Tracing of x-ray shown in Fig. 5.

sible coaptation of the fragments; second, the maintenance of the reposition; and, third, the subsequent treatment to restore function. It should be borne in mind particularly that the aim of the treatment of the fracture is to restore as promptly as possible the movement of the joint in its proper alignment, and the development of muscular strength, and, although it was formerly believed that perfect apposition was necessary in all fractures, we are convinced that such is not the *sine qua non* condition. Yet in fractures of the elbow-joint, this is of great importance because of the complicated structure of the joint.

With the elbow joint the main purpose should be to secure the prompt formation of a solid callus, which is firm, but not so large that it will inter-

FIG. 7

Case 1. S. L. After operation; lateral view, showing the parallelism of the projected curves of the joint.

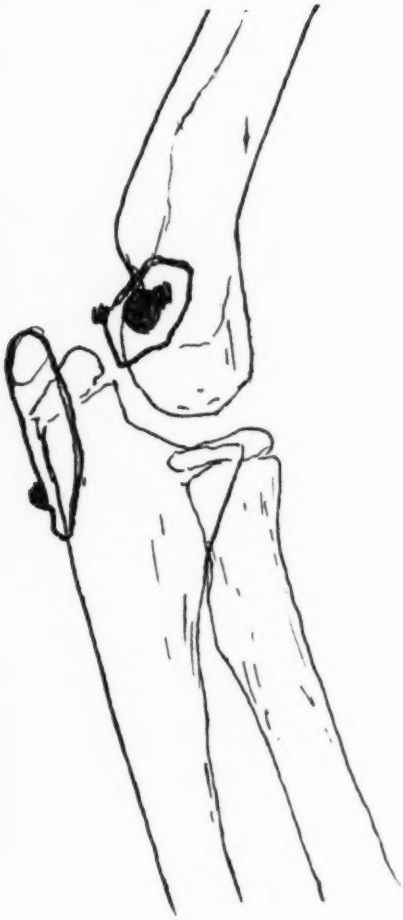

FIG. 8

Tracing of x-ray shown in Fig. 7.

fere with the early motion. Good results in the formation of such callus are obtained in direct proportion to good anatomical replacement, for under these conditions the osteogenetic evolution takes less time and is more uniformly distributed. For this reason it is necessary in this type to obtain the most complete anatomical replacement in order to secure the best functional restoration.

In the period after reduction, the treatment is of importance, for, as is well known, the joint has the peculiarity of producing fibrous exudate which forms large calluses tending to produce adhesions in the joint, with subsequent immobility, as well as muscle atrophy, due to nerve compression. An illustration is cited of the case of a child with internal condylar fracture in which imperfect early treatment had resulted in occlusion of the

FIG. 9

Case 2. S. E. Tracing of x-ray; lateral view, showing humeral fracture with five different fragments.

FIG. 10

Case 2. S. E. After operation; lateral view. Shows a screw in the lower part of the humerus and a projection of a Y-shaped plate in the upper part. The consolidation callus can be detected toward the anterior part of the humerus.

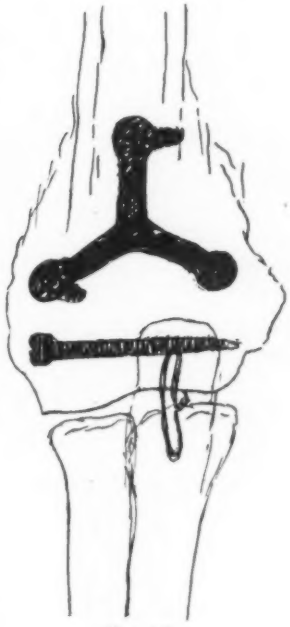

FIG. 11

Case 2. S. E. After operation; anteroposterior view. The joint is free and the callus is situated principally in the upper part of the bone.

cubital nerve during the osteogenetic process, requiring the dissection and separation of the nerve. Later a resection was performed, and finally, a second operation in which an injury to the epiphysis occurred. Even after undergoing massage, electrical treatment, etc., the child was left with an atrophied arm, a short and atrophied forearm, and marked deformity of the fingers and hands.

Our object, then, is to restore the displaced fragments as soon as possible and to hold them so firmly in position that the treatment for the maintenance of mobility may be begun early. This is closely in accordance with the teaching of Dr. Lucas-Championnière who recommended massage and immediate movement for the treatment of fractures.

It is very frequently seen in these complicated fractures that it is quite impossible to insure the complete reposition of the fragments by the indirect or external (non-operative) means, because of the difficulty of coapting the several completely displaced fragments which are again misplaced in manipulation. It is also difficult because of the groups of strong muscles which surround this joint.

It is not the purpose of this paper to compare the two methods, but it can be stated that in the bloodless method there is always the difficulty of keeping the joint immovable for a time long enough to allow the replaced

fragments to form sufficient callus to prevent their displacement when movement of the joint is begun. There is, therefore, the conflict in the treatment between the necessity of immobility in order to obtain coaptation and the use of mobility for the preservation of function.

The advantages of the direct or open method are easily understood when we consider the desirability of the maintenance of the position of the fragments.

First, an anatomical replacement of the bone fragments is possible.

Second, this coaptation is maintained by means of prostheses which may be handled and applied easily and which are sufficient to hold the fragments in position against any ordinary strain of muscle action in this joint, for we have to deal with several small epiphyseal fragments, which may be termed satellites. The means of replacement of the fragments will vary with the case, but we believe that in cases of complex fractures, as in the cases here reported, because of the difficulty of reduction of the small fragments and the trauma incident to the attempt, the reposition should be made not only as early as possible, but by the means resulting in the least trauma.

Third, the early restoration of function can be accomplished by this method even before consolidation takes place. The individual fragments are not isolated as before reposition, but, because of maintenance by the prostheses, form a single body.

In this method we strive to obtain the following:

1. Quick, easy, and free access to the articulation.
2. The placing of the prostheses to insure stability of the fragments.
3. The assurance that the prostheses are not so placed as to interfere with the articular surfaces.
4. Maintenance and the return of function.

The method of approach in these cases is through two straight incisions, united by a small curved incision starting at five centimeters from the articular line at the posterior part of the elbow and the superior side of the median line. The incisions are started on the posterior part of the elbow and united at the lower part by a curved incision, which is at the level of the olecranon. The incisions can be made with the arm extended or flexed and should expose the bone. The cubital nerve is isolated and the olecranon severed by a saw, if the patient is an adult, or by a knife, in the case of a child. With resection of the olecranon, free access to the joint is given, and the sectioning of the olecranon has not been found to have any disadvantage in the subsequent healing process. It is united later by a strong wire, and in all cases the consolidation has been complete.

For the prostheses, a screw from three to five centimeters long is valuable for fractures in which the trochlea and condyle are involved. Plates and wire also have been used without disadvantage. As before stated, care must be taken that the prostheses shall not be placed so as to interfere in any way with the articular surfaces. It is never necessary to drain.

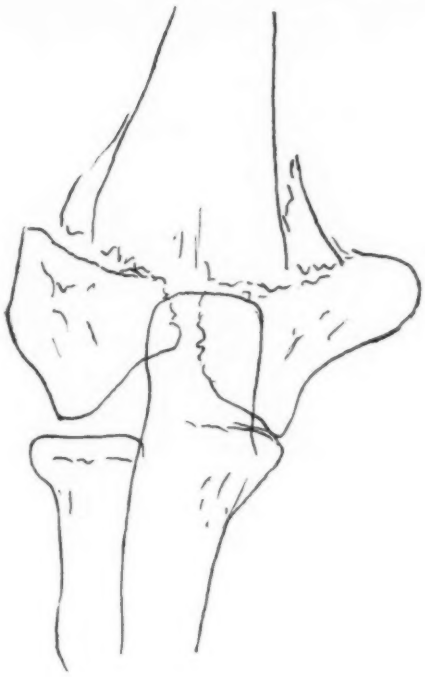

FIG. 12

Case 3. M. C. Tracing of x-ray, showing fracture of the humerus with five fragments.

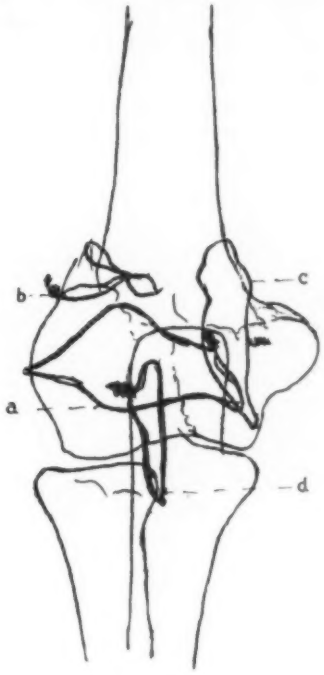

FIG. 13

Shows the use of four wire laps: *a* holding the two inferior fragments together and reconstructing the articular surface; *b* and *c* situated in the upper and lateral parts in order to fix the two upper small fragments to those connected by *a* and the whole to the lower part of the humerus; *d* holding the olecranon in place.

Fixation by plaster is never used because of the firm retention of the fragments by the prostheses, and because of the necessity of early treatment for function. Pasteboard splints are usually used, with the arm in extension, and are sufficient. This position is maintained from five to eight days, after which the splints are removed, and the patient is allowed to keep the arm straight for a few days. Eight days later, motion is begun with subsequent physiotherapy as necessary.

In cases treated by this method, no stiff joints have followed. This compares favorably with the other methods, for one frequently sees ankylosed joints following the closed method of treatment.

The following three cases, a child and two adults, show the results of the operative treatment in different types of fractures:

CASE 1. S.L., aged eight years. Four months previous to his admission to the hospital had fractured the elbow. Upon examination it was found that the fracture had not consolidated, was of the condylar type with separation of the condyle and epicondyle, as shown in Figures 1 and 2. In the lateral view only a lack of parallelism in the projection can be seen with marked limitation of the movements of flexion and extension and painful supination. An open operation, using transverse screw and wire, was followed by physiotherapy. Results are shown in Figures 5, 6, 7, and 8.

CASE 2. S.E. Entered hospital in coma with fracture of the base of the skull, and fracture of the right elbow showing five fragments of the humerus. After recovery from fracture of the skull, an operation was performed upon the elbow with local anaesthesia on the brachial plexus. The fragments were held in place with a transverse screw and a Y-shaped metal plate as shown in Figures 9, 10, and 11. End results show strong callus, firm union, and complete function.

CASE 3. M.C., a chauffeur. Admitted to hospital with fracture of right elbow fifteen days old, of type sometimes called motorist's fracture, caused by back-fire while cranking a car. The five fragments, irregular in shape, can be seen in Figure 12. An open operation was performed under regional anaesthesia. In this case it was not possible to secure suitable screws so wire was used, binding it several times until firmness was obtained. In spite of the fact that some of the wires were placed intra-articularly instead of intra-osseously, everything possible was done to adapt them to the contour of the surface. Function was restored and the patient is working again as a chauffeur.

These results are given in order to submit the author's impressions of the value of the open method in the treatment of severe fractures of the elbow.

TRAUMATIC DISLOCATION OF THE SHOULDER

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INTRODUCTION

It is usual to describe two main types of dislocation at the shoulder, subspinous or backward, and subcoracoid or forward dislocation.

In the material available to us there are but three cases of subspinous dislocation. These are all bilateral, more or less symmetrical, and undoubtedly not traumatic in origin, but produced by a deformity of the glenoid surface early in foetal life at the stage of preformation of the joint by cartilage. They have already been fully described.[1]

Our concern is with the frankly traumatic type comprised under the general heading of subcoracoid dislocation.

Among the collection of 1826 complete human skeletons in the Hamann Museum of Western Reserve University, twelve examples are presented of recurrent and unreduced dislocations, varying in degree, but all of traumatic origin. This high incidence is probably accounted for by the fact that, in this group, there was rarely much deformity. The patients, therefore, probably never sought surgical attention. In contrast with this, the unreduced dislocations of the shoulder seen by the writer in private practice have all been instances of frank subglenoid dislocation with considerably more deformity than those described in this paper.

SURGICAL CLASSIFICATION

A study of the specimens here recorded has prompted us to formulate the following classification:

A.	Congenital anomaly		Backward dislocation (subacromial, subspinous)
B.	Traumatic defects		
	Subluxation	I.	Stub
	Luxation	II.	Subcoracoid dislocation
		III.	Subglenoid dislocation
	Complication		Arthropathy following dislocation

I. SUBLUXATION OR STUB

The characteristics of subluxation or stub are exemplified by the following instances:

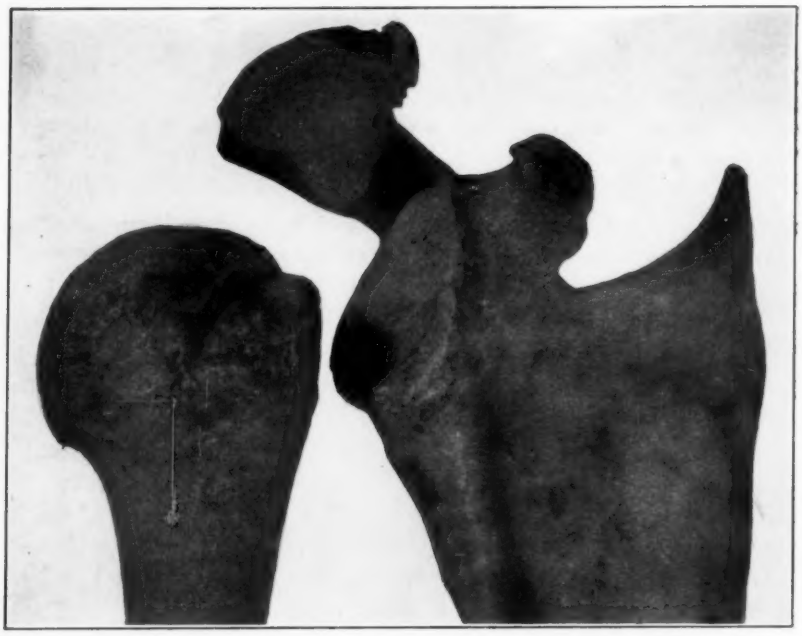

FIG. 1

Right humerus seen from behind, and glenoid surface of right scapula. W. R. U. 1751, male, negro, aged forty-eight years. Stub of shoulder. Note old healed compression fracture of ventral margin of glenoid, with slightly proliferative area on dorsolateral margin of articular head and smooth, flattened deformity of the greater tuberosity.

W. R. U. No. 1751, male, negro, aged forty-eight years, right shoulder (Fig. 1). In physical appearance the right shoulder was flattened, the humeral head formed a definite visible convexity just above the axilla, the acromion plainly projected laterally and there was some abduction and lateral rotation.

Examination of the macerated bones shows that the ventrolateral glenoid border is definitely roughened and slightly depressed. It is clearly the site of a healed compression fracture associated with dislocation. The dorsal margin of the humeral head shows proliferative change which extends, as a small, smooth, flattened area, to the adjacent part of the greater tuberosity. The humeral defect points to deformity with external rotation. The circumstantial evidence suggests hyperactivity of the infraspinatus associated with subscapularis weakness.

Almost identical with the above is the left shoulder, W. R. U. No. 1841, male, negro, aged forty-five years. It is probable that the real age of this patient was nearer thirty-five years. The stave of the ventral glenoid is not so extensive but is equally well defined. There is the same smooth, flattened area on adjacent aspect of the greater tuberosity. The physical appearance of the shoulder and the condition of subscapularis and infraspinatus muscles were probably precisely similar to those of No. 1751.

W. R. U. No. 1491, male, white, aged fifty years, was so fat that no superficial indication existed of the left shoulder defect. The ventral glenoid border is completely chipped off below for a distance of one centimeter, with surrounding recent bony proliferation. It is clearly the site of fairly recent stubbing fracture. On the surgical neck of the humerus, a little below and medial to the lesser tuberosity, there is a large exostosis simulating avulsed bone. Erosion is beginning on the dorsolateral margin of the humeral articular head with circumstantial evidence of unnatural external rotation.

The fourth and last of this class is the left shoulder of W. R. U. No. 1795, male, white, aged forty years. The physical appearance of this shoulder was precisely like that of Nos. 1751 and 1841. On the macerated skeleton there is absence of approximately one centimeter of the ventral glenoid margin which gives the impression of absorption after compression fracture. Humeral head and adjacent greater tuberosity show slight erosion. Like No. 1491, the demonstrable defect on the healed ventral glenoid margin permits undue external rotation at the shoulder joint.

The right glenoid of this skeleton shows a lesion very suggestive in the consideration of stubbing fracture. On the ventral aspect of the glenoid neck or base is a quiescent eroded and undermined area as of old bursitis in the subscapularis synovial extension, predisposing the ventral glenoid margin to fracture.

FIG. 2

Left humerus seen from behind and ventral aspect of scapular neck. W. R. U. 565, male, white, aged fifty years. Stub of shoulder. The recent origin is demonstrated in the new callus on the glenoid neck and the extensive erosion of humeral head which presents the typical granular appearance of freshly caused destruction.

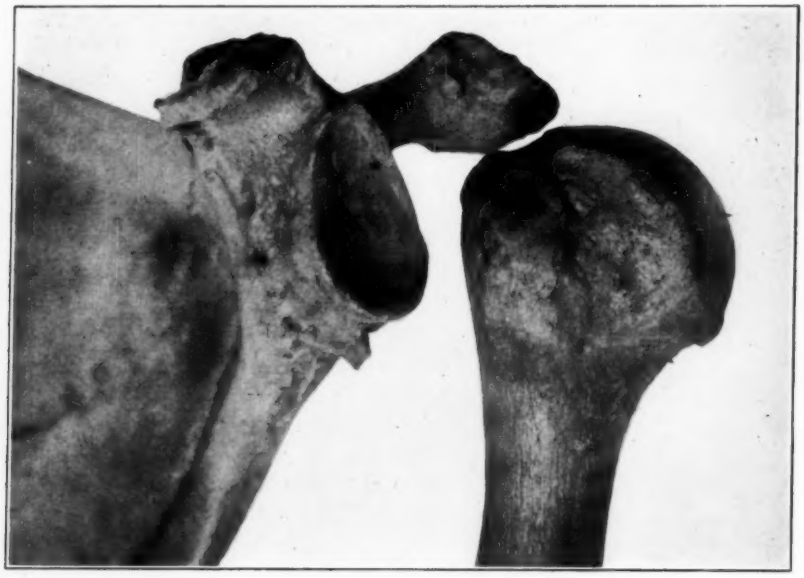

FIG. 3

Left humerus seen from behind and ventral aspect of scapular neck. W. R. U. 284, male, white, aged seventy years. Subcoracoid dislocation. Note the old-standing waxy bone proliferation on glenoid neck with sharpening of ventral glenoid margin, together with waxy, healed erosion on adjacent areas of humeral head and greater tuberosity.

II. SUBCORACOID DISLOCATION

In the subcoracoid group of dislocations, the laterally rotated humerus hangs over the ventral margin of the glenoid with an obvious functional defect of the subscapularis muscle.

W. R. U. No. 565, male, white, aged fifty years, shows a recent though typical dislocation of the left shoulder joint, with abduction and external rotation each of about forty-five degrees' extent (Fig. 2). The ventral glenoid margin itself is undamaged but the ventral surface of the glenoid neck shows an extensive mass of recent callus. The dorsolateral part of the articular humeral head and the adjacent part of the greater tuberosity are mutilated by an erosion of considerable extent which penetrates deeply into the cancellous bone. The erosion is definitely confined to the dorsal part of the humeral upper extremity and does not extend to its upper surface. The distribution of this erosion is the distinctive feature by which, on the macerated skeleton, subcoracoid and subglenoid dislocations are distinguished. Recent as the condition must be, a nearthrosis is in process of formation.

W. R. U. No. 284, male, white, aged seventy years, presents, in the left shoulder (Fig. 3), a condition precisely similar to that shown by No. 565, but of considerable standing. There is condensation of compacta

over the ventral glenoid margin with waxy exostosis (old callus) over the entire ventral aspect of the neck extending to the base of the coracoid. There is a healed erosion with a waxy surface involving the dorsal margin of the humeral head and adjacent part of the greater tuberosity. This erosion is shallow and its surface waxy and polished. It is, therefore, totally unlike No. 565 in its actual features, though belonging to the same class of injury.

In W. R. U. No. 1078, male, white, aged forty years, the right shoulder is indistinguishable in physical appearance from the stubs of the previous chapter. But for a slight flattening and an elongation, so small as to escape attention unless specially searched for, there was no abnormality. We cannot state the physical condition of Nos. 565 and 284 since, in those early days of the collection, photographic and anthropological records were not made. On the skeleton of No. 1078, which turns out to be a subcoracoid dislocation less recent than No. 565 but not of as long duration as No. 284, there is a crescentic-shaped erosion of the ventral glenoid margin and the neck beneath it where there is a small mass of fairly recent callus. Again, on adjacent areas of humeral head and greater tuberosity, posteriorly, there is a quiescent, slight waxy erosion. The specimen is then a frank subcoracoid dislocation in which the arm is maintained in a position of abduction and external rotation, each of about forty-five degrees. The

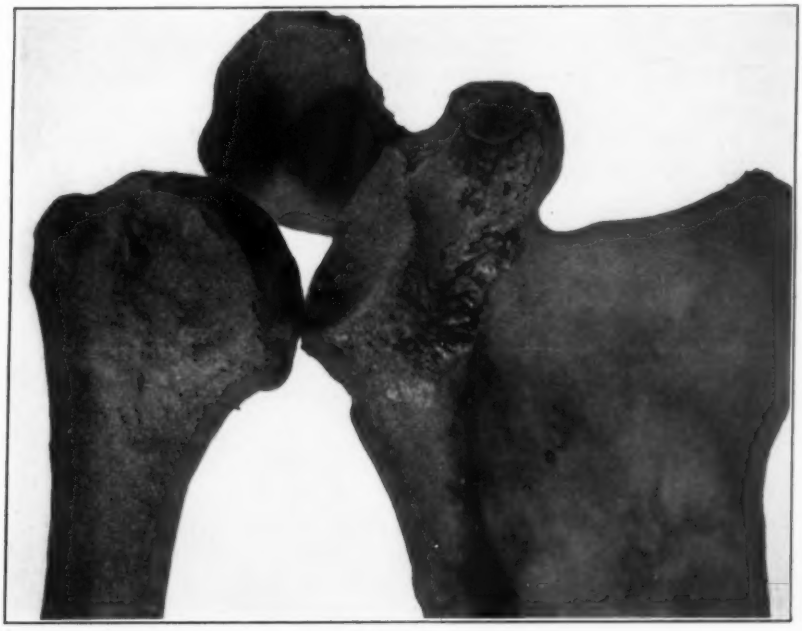

FIG. 4

Right humerus and ventral aspect of glenoid neck. W. R. U. 1770, male, white, aged forty-eight years. Subcoracoid dislocation. Note the marked erosion on humeral head and the eburnation of glenoid with very little proliferation.

nearthrosis was, during life, gradually increasing its range of motion commensurate with the degree of erosion.

W. R. U. No. 1770, male, white, aged forty-eight years, concludes our series of subcoracoid dislocations (Fig. 4). The condition was readily diagnosed on the cadaver by the characteristic flattened shoulder and elongated upper arm. On the skeleton we find erosion of the ventral aspect of the glenoid neck extending to the base of the coracoid. The angle of the coracoid had been fractured but this must have been a green-stick type, for it is healed in perfect position. A part of this eroded area has a smooth burnished surface apparently from friction of long duration. The non-burnished areas show some evidence of inflammation in their honey-combed condition.

The foregoing are all examples of subcoracoid dislocation with the upper extremity of the humerus closely tucked under the coracoid process. We now turn to a group in which the humeral head lies against the glenoid margin lower down. Of the four examples, only the last two (Nos. 274 and 1538) are so situated that they would be recognized as subglenoid at once,—namely, that class in which the dislocated humerus fails to slip closely up under the coracoid process.

III. SUBGLENOID DISLOCATION

The most apt way to describe the four following specimens is that, in the first and second, the humeral head has slipped down somewhat from the subcoracoid position close under the coracoid process, whereas, in the third and fourth, the humeral head is so definitely anchored on the lower part of the glenoid margin that there is no question of the distinction between them and the subcoracoid type.

W. R. U. No. 363, male, white, aged sixty-four years. The right shoulder shows erosion of a portion of the lower ventral aspect of the glenoid neck and margin. The eroded surface is polished and has slight peripheral proliferation. Adjacent parts of humeral head and greater tuberosity are likewise eroded slightly and the eroded surface is polished. It extends upward on the dorsal aspect of the bone, higher than in previously described specimens but not so high as to reach the top, as in Nos. 274 and 1538.

W. R. U. No. 1022 is our only female example. It comes from a negro woman of forty-six years. On the emaciated cadaver the right humeral head lay well below the clavicle and coracoid process. The condition was diagnosed at that time, however, as subcoracoid dislocation. In this specimen there is not the usual erosion of the glenoid margin. There is, instead, a disc of newly formed bone, about the size of a quarter, forming a nearthrosis on the ventral aspect of the glenoid neck. The glenoid surface itself is covered with bony proliferations associated with a profuse development of synovial tags. The humeral head is also partly covered with bony proliferations. There is no erosion of head or of greater tuberosity. In this characteristic, No. 1022 differs from the other specimens in

FIG. 5

Left humerus and ventral aspect of glenoid neck. W. R. U. 274, male, white, aged forty-five years. Subglenoid dislocation. Note features quite similar to those of subcoracoid dislocation, but involving upper rather than posterior part of humeral head and lower rather than mid-ventral aspect of glenoid neck.

our collection not in principle so much as in degree. The erosions of glenoid margin and of humerus are incidents to the relative positions of the bones. They are not essential but they must prejudice the results of treatment.

W. R. U. No. 274, male, white, aged forty-five years (Fig. 5). The left shoulder joint shows a healed recent erosion of the lower ventral glenoid margin and neck. A similar recent but very extensive healed erosion involves adjacent parts of the back and upper surface of humeral head and greater tuberosity. This extension to upper surface, characteristic of this and the next specimen, is the distinctive feature of the subglenoid dislocation. The humeral erosion in No. 274 is rough but not polished. There must have been marked abduction but little external rotation.

This is not a classic picture of subglenoid dislocation but it clearly illustrates the features of the condition which has been rather inadequately described in standard works.

W. R. U. No. 1538, male, Indian, aged sixty-three years, is the last of our subglenoid series. In the cadaver a slight flattening of the left shoulder, without other deformity or even recognizable lengthening of upper arm, was the sole indication of damage. The outward evidence in No. 1022 was far more pronounced than in this specimen. After preparation of the skeleton, we found on the lower ventral part of the glenoid margin a healed eroded area about one centimeter long which involved also a portion of

the neck. The usual erosion at back and upper surface of humeral head extending to the greater tuberosity is present and is now quiescent and waxy.

LUXATION COMPLICATED BY ARTHROPATHY

Before finishing the description of dislocation of the shoulder, mention should be made of a single specimen of unknown origin except that it was obtained from a white male beyond fifty years of age. This specimen of right shoulder joint, No. E361, shows a glenoid surface completely eroded and a semilunar nearthrosis on the ventral aspect of the neck, merging by a rounded margin with the glenoid proper. The humerus suffered a comminuted fracture of the anatomical neck which never united and is associated with a T-shaped deformity of the upper shaft. It is strange that the greater tuberosity survived. There is much ossification in the joint capsule and the long tendon of the biceps is completely ossified. The detached anatomical head was dislocated and lies in the subcoracoid position.

THE PRINCIPLES OF TRAUMATIC DISLOCATION

The injury that gives rise to traumatic defect of the shoulder joint relationships apparently consists usually of a stubbing fracture of the ventral glenoid rim. There is, at this site, an extension of the synovial membrane of the shoulder joint under the tendon of the subscapularis muscle, and it may be that an antecedent bursitis with consequent thinning of the bony glenoid margin may predispose to the damage.

Since our cases of stubbing fracture are accompanied by external rotation of the humerus, it is plain that some functional defect of the subscapularis muscle accompanies and indeed may be an integral part of the injury. True enough, No. 1022, which has no erosion of the glenoid margin, also showed far less external rotation of the humerus than the others. Indeed this is the only one in which anything like complete pronation was possible among the eight of which there are photographic and anthropological records (*i.e.*, Nos. 1751, 1841, 1491, 1795, 1770, 1022, 1078, and 1538). In this specimen the subscapularis had suffered practically no functional interference.

Nos. 565 and 284, of which we have no photographic records, require a little further explanation. At first sight they are quite similar to No. 1022 in that the glenoid margin is undamaged. They differ from No. 1022 in having an eroded humerus. They are, then, examples of a dislocation accompanied by functional defect of subscapularis but without stubbing fracture.

The characteristic indicator of functional defect in subscapularis is external rotation of the humerus with consequent inability to pronate the hand. We would not confuse the reader over these two movements, axial rotation of the upper arm and pronation-supination of the forearm. They are quite different, but the former greatly enhances the value of the latter movement. The anatomical defect in external rotation is an erosion of the humerus, but not necessarily of the glenoid margin. It would seem that

the unnatural pull of the dorsal scapular muscles, and the functional disadvantage in which the subscapularis is involved, bring about a pressure erosion of the humerus and glenoid margin, together with a locking of the arm in external rotation.

The two further stages of the traumatic dislocation—namely the subcoracoid and subglenoid forms—are merely the expression of physical anchorage of the shoulder in its new position. If the mid-ventral glenoid margin gives way and the back of the humerus be eroded, the subcoracoid form results. If, however, the lower ventral glenoid margin is involved and the upper surface of humerus is eroded, the subglenoid form results. There is, certainly, in our series, no evidence of transition from one to the other, such as is postulated in classic descriptions of the condition. It is apparent that the type of dislocation is determined by the details of the original injury.

In luxations complicated by arthropathies, we have a characteristic picture of bone destruction and proliferation, with normal relations entirely lost and features which are in part the result of bone defects and in part the consequence of damage to capsular structure and function.

In the formation of the nearthrosis the most striking feature is the evidence of fairly recent erosion of the humeral head associated with evidence of old healing in other parts of the joint. This can only mean that erosion continues long after the original trauma, when marked pain and muscle spasm have disappeared or are replaced by chronic "rheumatism" and muscle contracture.

TRAUMATIC SUBLUXATION OF THE SHOULDER JOINT

Although there is obviously no definite evidence for the following assumption, it is reasonable to infer that a certain proportion of these cases classified as traumatic defects were recurring subluxations, and others permanent unreduced subluxations. Of the twelve cases reported here, W. R. U. No. 1751, No. 1841, No. 1491, and No. 1795, classified as stub, may be rightfully considered as having been cases of recurring subluxations, as demonstrated by the position the component parts of the shoulder joint assume in the physiological and subluxated positions. It is possible that some of the cases described as subcoracoid dislocations may be grouped in the category of recurrent dislocations, particularly No. 565, and probably No. 284, in which there is evidence of a fairly recent process of the formation of a nearthrosis.

Roentgenologic examination of all the shoulder joints classified as stub, with the scapula and humerus in their physiological and subluxated relations, fails to reveal any evidence whatever of defect in the humeral head or the glenoid. In a recent paper, Henderson[7,8] stated that defects in the glenoid cavity have been advanced as a cause of subluxation, but that proof of this by roentgenograms or by observation at operation has been lacking.

The writer examined a large number of roentgenograms taken to check reductions of traumatic dislocations of the shoulder in a large clinic and, with the exception of definite evidence of fracture in the head or neck of the humerus or in the scapula, there was not a single case in which injury to the humeral head or glenoid could be demonstrated. Surely, with the large number of traumatic subluxations occurring and roentgenograms taken after reduction, many of these reported negative for bony injury must have sustained a trauma similar to that demonstrated in our series. When one considers the difficulty of obtaining roentgenologic detail in the shoulder joint, especially in the anteroposterior plane, such defects as found in this first series may easily be overlooked.

Of the various measures proposed for the relief of recurring dislocations, it is invariably inferred that the subluxation is due either to laceration or relaxation of the joint capsule. However, the incidence of twelve in approximately eighteen hundred complete skeletons, or about six-tenths of one per cent., must be given due consideration as an important etiological factor in these cases. In pathological dislocations, such as resulting from poliomyelitis, Erb's palsy, etc., there is a definite relaxation of the joint capsule; but in traumatic dislocations, bony injury or laceration of the capsule, or both, are the etiological factors.

Reviewing the surgical operations described for the recurring cases, there are in the main two types: first, those which aim to reefing and repair of supposedly relaxed and lacerated joint capsules, as exemplified by the Thomas operation[2]; and second, those which limit the range of motion of the shoulder joint between the humeral head and glenoid by improvised check ligaments,—such as the Clairmont[3], and Henderson[7] procedures; or by bone block,—such as the Speed[4] operation.

Henderson subdivides these operations into five types: first, those performed on the bony structures, such as the Speed operation; second, those performed on the capsule, such as the Thomas operation; third, correction by muscle transference and muscle lengthening, which is exemplified by Clairmont's operation; fourth, check and block operation, such as the Gallie and Le Mesurier method[5]; and fifth, suspension operations, which are exemplified by the Henderson procedure. Without attempting to produce any actual statistics of end results, an inquiry has shown that there have been more failures from capsule reefing and repair operations than from those with check ligaments and bone-block procedures. Is it not possible, therefore, that many of the failures following capsulorrhaphies may have been due to the fact that the surgeon was dealing with a case of bony defect, as described in our series, rather than to capsular trauma or relaxation?

SUMMARY

1. Herein are described twelve instances of traumatic dislocation of the shoulder joint. Eight have been carefully studied: first in the cadaver, next by dissection, and lastly on the macerated skeletons. The other four are known only by the skeletons.

2. These twelve lesions emanate from a collection of 1826 complete skeletons of known individuals. The high percentage is probably due: first, to the class of patient who does not readily seek medical advice for a disability; and, secondly, to the relatively minor degree of disability apparently suffered by most of the twelve.

3. The classic description of the production of traumatic shoulder dislocation is not borne out by these examples.

4. In the original injury the humeral head has been forced over the glenoid margin in the region of the subscapular bursa. This is accompanied by either a stubbing fracture of the ventral glenoid margin or by a functional disability of the subscapularis muscle, or both.

5. In the subluxation or stub, the healed glenoid margin is no disability but the functional damage sustained by the subscapularis becomes the important feature. The humerus is externally rotated and is slightly eroded on its dorsal aspect adjacent to the greater tuberosity, even though the head never leaves the glenoid cavity. This condition may escape notice or be diagnosed as rheumatism.

6. Subscapularis bursitis seems to have some influence in predisposing the joint to traumatic dislocation through thinning of the glenoid margin.

7. In the true luxations the head leaves the glenoid and the final category depends upon the site of glenoid injury. If the mid-ventral margin is damaged, subcoracoid dislocation results; if the lower ventral margin is affected, subglenoid dislocation occurs. In such conditions the humeral erosion is more or less deep, depending upon extent of glenoid damage and muscular action.

8. This humeral erosion apparently continues long after the original pain and muscular spasm have given place to "rheumatism" and muscular contracture.

9. Stubbing fracture of the ventral glenoid margin, old synovitis of the subscapularis bursa, and traumatic functional deficiency in the subscapularis muscle are the three contributing causes to traumatic dislocation of the shoulder, so far as can be ascertained from our material.

10. It may be inferred that many of the cases herein described, especially those classified as stub, were cases of recurring subluxations of the shoulder joint. In view of the fact that we have definitely demonstrated the presence of bony defect, operative correction should be planned with view to correction of the subluxation by check ligaments and bone-block operations rather than by capsulorrhaphies.

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LIVER MEAL IN THE TREATMENT OF AMYLOIDOSIS IN SURGICAL TUBERCULOSIS*

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The development of amyloidosis in surgical tuberculosis is comparatively rare, but when it occurs it almost always terminates fatally. Very few patients have been known to recover. The very few cases of recovery from lardaceous disease that have been reported[1] followed radical surgical procedures. Hence it has always been justly feared as a complication. It results from long continued suppuration following the breaking down of an abscess and the formation of one or more sinuses which have continued to discharge over a long period of time.

This condition is accompanied by marked emaciation, waxy pallor, and prominence of the abdomen due to the gradual enlargement of the liver and spleen, which may occur to a marked degree. Prominence of the superficial abdominal veins is always noted; ascites is frequently a distressing complication. Secondary anaemia, progressing to the extreme in many cases, is always present. Large quantities of albumen are found in the urine. Death follows at the end of several months from exhaustion, failure of the portal circulation and cardiac failure.

The beneficial results from the use of liver meal in these cases were found by us as if by accident. The advantage of its use in secondary anaemia was realized and because of this fact we began its administration in Case 1 of our series about two years ago in an effort to combat this steadily progressive anaemia.

Newton[2] noted significant improvement of the anaemia and of the general condition of patients with pulmonary tuberculosis following the use of a liver extract. Grayzel *et al*[3] showed that the addition of small quantities of powdered whole liver to the diet retarded definitely the production of amyloidosis in white mice. Several investigators[4] have reported favorable results in cases of pulmonary bone or joint tuberculosis, treated with powdered whole spleen, splenic extract, or a mixture of spleen and bone marrow.

In this preliminary report we are presenting seven cases which, at the time of the beginning of treatment with the liver meal, presented definite symptoms and physical signs of amyloidosis in varying degrees of severity, —*i.e.* emaciation, waxy, yellowish pallor, a severe secondary anaemia, large prominent abdomen with markedly enlarged and firm liver and spleen, and large quantities of albumen in the urine, with waxy casts in most cases.

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The active tuberculous infection of the bones, complicated by several profusely discharging sinuses, had been present for two or more years. Furthermore, the Congo-red test for the diagnosis of amyloidosis as described by Bennhold and others[5] was positive in each case. Three patients had far advanced amyloidosis secondary to Pott's disease. The other four presented a moderately advanced type of amyloidosis: two were secondary to tuberculosis of the hip joint, and the remaining two to tuberculous osteitis of the knee joints. All of the seven children were doing poorly and were growing worse rapidly before the institution of the treatment.

The specific therapy consisted of the administration of a concentrated powdered whole liver in three daily doses of four grams each for a period of two years. In addition the children were confined to their beds and received daily salt baths and dressings, and heliotherapy or ultra-violet light therapy. An adequate diet including all the vitamins was given.

RESULTS

Of the seven children treated, two died; the remaining five showed no clinical evidence of amyloidosis at the end of twelve to eighteen months of treatment.

One child, after five months of treatment, died of an intercurrent pulmonary infection. The demise of the other child occurred fourteen months after the institution of this therapy. In this patient, there was evidence of resorption of the amyloid substance. This was shown by a significant reduction in the size of the liver and the spleen. The palpable portion of the liver decreased in length from seven to three inches, and that of the spleen from six to two inches. The hepatic measurements were made from the mid-point of the right costal margin, and those of the spleen from the mid-point of the left inferior border of the ribs. Following the recession of these organs, recurring ascites set in, which did not respond to medicaments or to frequent paracentesis. This complicating condition was probably responsible for death due to cardiac failure. In this child, therefore, there is some reason for believing that, under the influence of this particular therapy, the amyloid was in the process of being gradually resorbed. It may be that the recurrent ascites was caused by portal obstruction due to a replacement fibrosis of the resorbed amyloid. An autopsy was refused by the family.

The other five children are still alive. They all showed definite improvement within three months. After this period, progressive betterment was noted in their general condition, in their tuberculous infection, and in the amyloidotic symptomatology. The favorable retrogression of the amyloidosis proceeded at a much greater pace than the tuberculous infection. It was observed that the recession in size of the liver and of the spleen occurred even during the active stage of the infection as determined by elevation of temperature and by the profusely discharging sinuses. By the

eighteenth month, the general appearance and state of nutrition of these patients was good; the secondary anaemia was mild or had even disappeared entirely; the abdomen was not prominent, and the liver and spleen were no longer palpable. Thus no clinical symptom characteristic of amyloidosis was present. However, the Congo-red test was still positive, indicating that sufficient lardaceous material was present in the organs to absorb the dye and remove it completely from the blood.

CASE 1. J.G. This was the first case in which the treatment with liver meal was instituted. The treatment was begun with the idea of improving, if possible, the extreme state of secondary anaemia.

This boy is fifteen years old at the present time. He had a well marked lumbar Pott's disease with discharging sinuses in left iliac region. These sinuses had discharged continuously for three years and during much of this time he had an afternoon temperature of 101 to 102 degrees and physical signs of amyloidosis developed. He began to grow worse and two years ago his condition became so serious that death seemed imminent. At that time the sinuses were discharging freely; his temperature continued. He was extremely pale and waxy in appearance. The abdomen was markedly distended; the superficial veins appeared prominent; the liver could be palpated at the line of the umbilicus, and the spleen two and one-half inches below the free border of the ribs. Albumen in the urine was four plus. Ascites then began to develop to a considerable degree. He had occasional hemorrhages from the nose and rectum and had vomited blood; there was no hemoptysis. His hemoglobin was forty-five per cent.

On April 14, 1929, the treatment with liver meal was begun; four grams were given three times a day. This treatment was continued during the following months and, much to our satisfaction, a definite improvement in the boy's general condition was noted. Five months after starting treatment the abdominal distention had diminished; there was no dyspnoea or cyanosis. The dilatation of the superficial abdominal veins had disappeared, the liver and spleen had noticeably diminished in size, and no ascites was present. In November 1929, two months later, the hemoglobin had risen to fifty-eight per cent. and his general condition had markedly improved; the sinuses had been closed for three months. Two months later, in January 1930, he was allowed up. At this time the liver was palpable two inches below the free border of the ribs; the spleen was barely palpable; the sinuses remained healed. Two months later the liver was palpable one and one-half inches below the border of the ribs and the spleen was not palpable. The boy's general appearance was strikingly improved. His color good and he was active and up and about daily. He had gained several pounds since the inception of the treatment.

At the present time the boy is the picture of health, and is going to school. He has splendid color; the abdomen is only slightly distended; the liver is palpable about one inch below the ribs, the spleen not palpable; no superficial abdominal veins are apparent; his hemoglobin is eighty per cent.; sinuses remain healed.

CASE 2. C.I. This boy was admitted to Neponsit seven years ago with tuberculosis of the left knee and right ankle. He was in very poor condition, both the knee and ankle were markedly thickened, swollen, and indurated; and there were numerous freely discharging sinuses about both joints. The boy was emaciated and very anaemic. Boy continued to grow worse until, in March 1928, the child was thin; his appetite was poor; the abdomen was very prominent, with marked dilatation of the superficial veins. The liver was palpable three inches below the free border of the ribs and the spleen two inches below the ribs. The hemoglobin was fifty-five per cent.; the red-blood-cell count, 2,550,000. At this time, the liver-meal treatment was instituted, one dram given three times a day.

From this time on the boy began to improve and in June 1928, three months later, the examination showed the abdomen was still prominent, with moderate dilatation of

the superficial veins. The liver had diminished in size to a little less than two inches below the free border of the ribs, the spleen was palpable one inch below the free border of the ribs. The hemoglobin had increased to seventy-five per cent. and the red blood cells to 4,450,000. In November 1928 the boy's condition was markedly improved; temperature was normal; he had gained eight and one-half pounds in a period of ten months. There was no distention of the abdomen, no dilatation of the superficial veins; liver and spleen were not palpable; the hemoglobin was sixty per cent.

In July 1930, the boy's general condition and appearance were excellent; there was no distention of the abdomen, and no dilatation of the superficial veins; liver and spleen were not palpable; and the hemoglobin had risen to eighty per cent. The sinuses in the ankle had entirely healed and there was only a slight discharge from the sinuses about the knee.

Case 3. E.L. This boy was admitted to the hospital in October 1928 in very poor condition. He had tuberculosis of the left knee and was wearing a Thomas knee brace with a high shoe on the opposite foot. The knee was markedly swollen and presented a typical fusiform appearance. There were numerous sinuses discharging freely about the joint. There was slight motion in the joint which was very painful. The liver was palpable two inches below the free border of the ribs, spleen was not palpable. Hemoglobin was thirty-five per cent., red blood cells 2,230,000.

In January 1929, the boy's general condition had not improved; he was markedly emaciated with pallor of the mucous membranes and finger nails; his appetite was poor. The abdomen was very prominent with dilatation of the superficial veins. The liver was palpable at a line with the umbilicus and the spleen was palpable about two inches below the free border of the ribs. The sinuses in the knee joint were discharging profusely; hemoglobin was thirty-five per cent., red blood cells 2,230,000. At this time the liver-meal medication was begun, one teaspoonful three times a day. The child soon began to improve: the discharge from the sinuses began to diminish, and the knee was less painful.

In June 1929, examination showed considerable improvement in the knee joint and less discharge from the sinuses and the boy's general condition showed a marked change for the better. There was slight distention of the abdomen; liver and spleen were not palpable. In September 1930 hemoglobin had risen to seventy-five per cent. The sinuses in the knee joint were entirely healed; liver and spleen were not palpable.

Case 4. M.N. This boy was admitted to the hospital in July 1926, with tuberculosis of the right hip and a large abscess in the upper third of the right thigh. This was incised, six ounces of greenish-yellow pus were evacuated, and the wound was closed with catgut sutures. Liver and spleen were not palpable at this time. In December 1927, the child's general condition was poor; he had lost considerable weight; appetite was poor; the skin was a yellowish-brown in color. The sinuses about the hip joint began to discharge freely; abdomen was distended; superficial veins were prominent; liver and spleen were each palpable one inch below the free border of the ribs. In January 1928, the child had failed still further, the liver was palpable about three inches, and the spleen one and one-half inches below the free border of the ribs. In March 1928 the same condition was present, hemoglobin had dropped to forty per cent.; red blood cells were 2,750,000 at this time. The liver-meal treatment was instituted, one dram given three times a day.

In August 1929 the boy's temperature was normal. Five months later he showed considerable improvement; temperature was normal; appetite was good; color of the skin and mucous membranes had shown a marked improvement; abdomen was not distended; liver was palpable about one and one-half inches below the free border of the ribs, and spleen was not palpable. One year later, in October 1929, the boy's condition was excellent; he had gained five and one-half pounds. There was no distention of the abdomen; the liver and spleen were not palpable. Hemoglobin was sixty-five per cent. In May 1930, the boy developed erysipelas and was very ill. He recovered and in September 1930 his hemoglobin had risen to seventy-five per cent., but there was some distention of the abdomen, with no dilatation of the superficial veins; the liver was just palpable below the free border of the ribs and the spleen was not palpable.

Examination of the boy in March 1931, showed a considerable improvement in his general condition; his lips and ears were regaining their color, his appetite had improved, his temperature had disappeared, and the discharge from the sinus was diminishing. The liver and spleen were not palpable and the hemoglobin was seventy per cent.

Case 5. R.H. The child was admitted to the hospital in July 1927, in fair condition. He had an active pulmonary tuberculosis, with a very extensive kyphosis from the fourth dorsal to the second lumbar vertebrae, and discharging sinuses in the right groin with moderate discharge. He had a daily temperature of 99 to 101 degrees and an active cardiac disease. In December 1928 the condition was quite poor; liver was barely palpable; spleen was not palpable; there was a moderate discharge from the sinus in the right groin. In July 1929, the child's condition was fair; there was considerable distention of the abdomen; liver was palpable three inches below the free border of the ribs, spleen was barely palpable. In November 1929, the child's condition was about the same,—hemoglobin was fifty-five per cent., the liver had enlarged to the level of the crest of the ilium and the spleen was about two inches below the free border of the ribs.

At this time liver-meal treatment was instituted,—one teaspoonful three times a day. The heart became weaker, and the lung condition became very active; but, in spite of these conditions, the liver and spleen began to diminish in size. In January the liver was palpable two inches and the spleen one inch below the free border of the ribs. Because of a rule in the hospital against retaining such far advanced cases of pulmonary tuberculosis, the boy was discharged at this time and died shortly afterwards. A notable point in this case, in spite of the serious condition, was diminution in the size of the liver and spleen under treatment with liver-meal.

Case 6. E.A. The boy was admitted to Neponsit in October 1925 in fair condition, with a discharging sinus over the left ilium. Previous to admission he had had a bone graft for Pott's disease in the lumbosacral region. In December 1926, the boy began to run an afternoon temperature, with less discharge from the sinus and with some tenderness and distention of the abdomen. This distention continued, with some discharge from the sinus, and with an afternoon temperature of about 102 degrees. In May 1927, the boy's condition was poor; pulse was rapid, and he had lost considerable weight; liver and spleen were not palpable. In December 1928, the child's condition was very poor, showing advanced amyloidosis; spleen was palpable two inches below the free border of the ribs; liver was palpable in line with the crest of the ilium; hemoglobin was thirty-eight per cent. At this time liver-meal treatment was instituted,—one teaspoonful three times a day.

In January 1930, the child had evidently improved since the administration of the liver meal; the liver had diminished in size to a line with the umbilicus and the spleen was palpable just above the line of the umbilicus. There was beginning pinkness in the cheeks, fingers, ears, and lips; but at this time the boy began to develop ascites. Frequent tappings were necessary to relieve the distress in breathing. When the abdomen was greatly distended it was impossible to feel the liver and spleen, but each time the abdomen was tapped it was found that the liver and spleen were diminishing in size. In March 1930, patient was much more comfortable; there was marked improvement in the color of the lips and ears, and palpation of the liver showed that it had diminished in size to about one inch above the umbilicus.

In October 1930, hemoglobin had risen to fifty per cent., but the ascites continued to be a very distressing symptom and his reaction to the tapping was not satisfactory. Heart again became poor and the child was distressed for breathing at the time. In January 1931, following the tapping of the abdomen, the liver was found to be two inches and the spleen one inch below the free border of the ribs. The heart action was poor and irregular and, on January 14, 1931, the boy died from cardiac failure.

Case 7. S.B. The boy was admitted to Neponsit Hospital May 1926 in fair condition, wearing a long plaster spica. The plaster was removed, the hip was in 170 degrees of extension and fifteen degrees of abduction. There was slight motion at the hip joint. There were several healed scars about the hip as a result of operations before

admission, and there was a sinus behind the greater trochanter which was discharging freely. The first few months the boy showed some improvement, but gradually grew worse and, in July 1930, he was in very poor condition; abdomen was prominent with enlargement of the superficial veins; liver was palpable one and one-half inches and spleen about half an inch below the free border of the ribs. Hemoglobin was forty per cent.; the sinuses were discharging freely, and the boy was running an intermittent temperature.

At this date, the liver-meal treatment was instituted,—one dram three times a day. From this time on, the boy began to show steady improvement. In September 1930, the sinuses were all healed about the hip joint; motion in the joint without pain had increased; extension was possible to 160 degrees, flexion to 115 degrees. In November 1930, the sinuses were healed; flexion at the hip was possible to 100 degrees; there had been no recurrence of the active symptoms.

In January 1931, the child was in fine condition. All the sinuses about the hip joint and left shoulder remained healed; liver was just palpable below the free border of the ribs and spleen was not palpable; distention of the abdomen had disappeared and the superficial veins were not prominent; hemoglobin was fifty-five per cent. Examination on March 25, 1931, showed the boy to be in fine condition,—his complexion was good; he had gained considerable weight; there had been no recurrence of the process in the left shoulder; liver and spleen were not palpable; there was 160 degrees of extension in the right thigh and fifteen degrees of adduction; flexion was possible to ten degrees; hemoglobin was seventy per cent; the sinuses remained healed.

The x-ray in this case originally showed marked disease of the right hip joint with destruction of the head of the femur and marked destruction and enlargement of the acetabulum. In November 1930, four months after the institution of the liver meal, it was noted that there was improvement in the appearance of the focus in the acetabulum. An artificial shelf had formed in the upper border of the acetabulum which would prevent subluxation at the neck of the femur. In February 1931, the x-ray showed a marked increase in the healing process taking place within the acetabulum.

DISCUSSION

Amyloidosis is a condition which is secondary to a long continued suppurative or wasting disease. Its etiology is still unknown. Some believe it to be a degenerative condition, resulting from changes in the organs due to cellular autolysis. Others consider it to be secondary to a protein metabolic disorder[6] in which the amyloid substance or its precursor is deposited in the reticulo-endothelial system of the various organs[7,3].

The development of amyloidosis may be viewed tentatively as follows: In an infection or wasting disease, there occurs an excessive destruction of cells. The products of this disintegration must be metabolized to their end products, or to a form that can be utilized or excreted by the organism. The site of this endogenous metabolism is as yet unknown. However, it is likely that an important rôle in this process is played by the reticulo-endothelial system. The latter consists of fixed and circulating cells which are scattered throughout the body, but are present in a greater measure in the liver, spleen, and kidneys. These cells probably possess chemical substances, which may be of the nature of ferments or enzymes, which either disintegrate or transform the foreign or toxic substances into a form which can be utilized by the tissue cells, or which can be eliminated through the excretory channels. However, when even this system cannot alter the particular substance either through its chemical inability or through exces-

sive production of this substance, then the latter is deposited in the reticulo-endothelial system. The deposition continues just so long as the body is overwhelmed with the non-metabolized material, since the body cannot eliminate it as fast as it is being formed.

Then, there occurs a progressive accumulation of the amyloid substance, which after a time interferes with the function of the organs. Mechanical pressure results in atrophy and death of the normal tissue cells of the organs in which this material is lodged. The amyloid material, after its infiltration, undergoes progressive changes in its composition[8] and, as it goes through several stages in its formation, becomes more stable and more resistant. Formerly it was considered to be a permanent infiltration. Recently clinical[1] as well as experimental evidence[9] has shown that it can disappear, if the exciting cause is removed before advanced changes set in.

The manner in which the liver preparation affects the resorption and the disappearance of the amyloid material is not as yet known. It is possible that the powdered liver contains an active principle which participates directly or indirectly in its catabolism. The liver is well supplied with reticulo-endothelial cells. Furthermore, there is some experimental evidence that the Kupffer cells of the liver, which are part of this system, have the capacity of disintegrating the lardaceous substance. It may be, then, that with the administration of the liver, the organism is supplied with additional amounts of specific chemical substances which the cells of this system possess. The exogenous supply supplements the relatively similar endogenous material, which is inadequate under the circumstances. This tentative explanation may possibly account for some success reported by others[4] with the use of spleen and bone marrow, which contain reticulo-endothelial cells.

SUMMARY

Powdered whole liver was used in cases of general amyloidosis secondary to bone tuberculosis. Seven children were given this therapy. One died shortly after the treatment was started. Another child died after fourteen months of treatment, although retrogression of the lardaceous disease was evident. In this instance, probably irreparable changes set in prior to the inception of the therapy. The remaining five showed no clinical signs of amyloidosis after treatment for a period of eighteen months.

In presenting this subject, it should be stated that the study was carried on at the Neponsit Beach Hospital for surgical tuberculosis in children, at Neponsit, Long Island, in collaboration with Dr. Harold Grayzel, who is in charge of the Pediatric Service at the hospital, and to whom much of the credit is due for the work presented in this report.

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LATE RUPTURES OF EXTENSOR AND FLEXOR POLLICIS LONGUS TENDONS FOLLOWING COLLES' FRACTURE*

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Late spontaneous rupture of the extensor pollicis longus tendon is a rare complication of Colles' fracture, having been reported only twenty-seven times in the literature. However, the writer has been unable to find a reported case of late spontaneous rupture of the flexor pollicis longus tendon following Colles' fracture. One case of late rupture of extensor pollicis longus and one of late rupture of the flexor pollicis longus tendons are reported.

Subcutaneous tendon ruptures at the wrist are relatively uncommon from all causes. However, rupture does occur as a result of disease processes and trauma. Mason has recently made a thorough study of rupture of the tendons of the hand.

A normal tendon is so strong that, when great strain is placed upon it, rupture of the fibers is rare. If it occurs at all, usually, either the periosteal insertion of the tendon gives way, often carrying with it a fragment of subjacent bone (Hunt); or rupture occurs at the musculotendinous junction (Odermatt, Adams); or the bones fracture; or subluxation occurs (Honigmann). Adams reported a case demonstrating the great strength of tendon fibers. A seaman caught his right third and fourth finger tips in a door jamb. On jerking his hand away, he suffered a traumatic amputation at the distal interphalangeal joint of the third right finger and with it pulled away "fifteen inches" of the flexor profundus digitorum tendon and some muscle fibers. The rupture in this case occurred, not in the tendon, but at the musculotendinous junction.

For rupture of a wrist tendon to occur, it must either be damaged by disease processes first, or follow trauma, single or multiple. Pathological conditions predisposing to tendon rupture are tuberculous tenosynovitis (Kanavel), gonococcic tenovaginitis (Melchior), syphilis and tumors of tendons (Odermatt). A discussion of necrosis of tendons following a suppurative tenosynovitis will not be considered in this paper.

Mason, quoting from Kanavel's files, reports that, out of twenty-one available records of tuberculous tenosynovitis in the hand, rupture or impending rupture of tendon was noted in ten instances. Only one case of gonococcic tenovaginitis causing rupture of a hand or wrist tendon, reported by Melchior, could be found. Syphilis was mentioned as a possible cause of wrist tendon rupture by Odermatt, but no reported case could be found. Tumors of tendon were also mentioned by Odermatt as a possible cause of rupture and, although numerous reports of cases of tendon and tendon-

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sheath tumors were found (Weir, Russell, Mathews, White, Kurtz, Burman and Milgram), none of these had led to tendon rupture.

Trauma causes by far the largest number of tendon ruptures at the wrist. Lacerations from external forces with severance of tendons is not an uncommon experience, especially in the field of industrial surgery. Excluding this type of injury, the condition which probably causes the largest number of wrist tendon ruptures is drummer's palsy, first described by the Germans as "*Trommlerlähmung*", and the tendon practically always involved is the extensor pollicis longus. It had been noted by German army surgeons that a number of drummers, especially the younger ones, developed a paralysis of the extensor pollicis longus tendon, usually on the left hand. At first this was considered a paralysis of the muscle, but Düms showed it to be a rupture of the tendon. The rupture follows a chronic tenosynovitis, resulting from the repeated trauma to the tendon, by the particular method of holding the drumsticks and the vibratory motion set-up in it. This condition has occurred in occupations other than that of drummers, such as,—tailoring (Hunt), carpentering (Barnes), and cane-making (Duplay). The pathogenesis, namely chronic tenosynovitis, is essentially the same in these, as in drummer's palsy.

A study of the anatomy of the extensor pollicis longus tendon will help in an explanation of this condition. It arises from the lateral part of the middle third of the ulna, passes downward and lateralward, ending in a tendon which passes through a separate compartment in the dorsal carpal ligament, which holds it in a narrow bony groove, on the back of the radius. After emerging from this compartment, it forms an angle obliquely around the lateral bony ridge of the radial groove, crossing the tendons of the extensor carpi radialis longus and brevis, and is inserted into the base of the distal phalanx of the thumb. On the wrist it forms the ulnar-bounding tendon of the anatomical snuff-box.

The chronic tenosynovitis occurs at the distal border of the radial groove where the tendon turns obliquely lateralward around the lateral bony ridge of the radial groove. The degenerative changes, consisting of swelling, inflammation, and aseptic necrosis, cause the tendon to rupture during a spasm of drumming, or during no strenuous exertion, as merely putting the hand in the pocket in search of an article, illustrated in the case reported by Hunt.

Duplay in 1876 seems to have reported the first case of subcutaneous tendon rupture in the wrist, in a woman thirty-six years of age, a cane-maker, who fell while carrying a bundle of canes, causing a violent torsion of the right thumb. There was immediate inability to extend the thumb. At operation, he was unable to bring the separated tendon ends together, so made a buttonhole in the extensor carpi radialis longus and sutured the distal end of the extensor pollicis longus in it. Despite a subsequent infection, good function was present in the thumb in less than seven weeks from time of operation.

Another trauma causing tendon rupture in the wrist is Colles' fracture. Here there is but a single injury and not a series of repeated minor traumata

to the tendon such as occur in the above named conditions, producing chronic tenosynovitis.

Compared to the many wrist fractures continually encountered, there are very few late ruptures of the extensor pollicis longus tendon as a sequel. Kleinschmidt, in a review of the literature up to 1929, found a total of twenty-five reported cases. Coenen later reported a case occurring in a fifty-seven-year-old woman. Lülsdorf, in 1929, reported a case occurring in a fourteen-year-old girl and these, with the case here reported, make a total of twenty-eight.

The condition may occur at any age but is most common after thirty, the youngest patient being fourteen. Nineteen of the twenty-eight have occurred in women and nine in men. The rupture usually occurs from three weeks to three months following the fracture.

The pathogenesis of this condition has been subject to controversy. However, there has been no preexisting condition, either of a general or local nature, found in the histories or examinations of these patients to account for the rupture. Hence, it must be assumed that the tendon is so injured at the time of the fracture that rupture subsequently takes place.

Kleinschmidt, in attempting to account for the rupture, first thought there might be a preexisting tendon disease predisposing to the rupture, but this has not been substantiated. Later, however, he carried out a number of experiments on cadavera in which he produced what he termed the typical radius fracture, by extending the hand and thumb and delivering a hard blow to the flexed elbow. In each of these he found a small tear in the extensor pollicis longus tendon, or its sheath, from a sharp fragment of the fracture.

Weigeldt and Hauck each have described the rupture as due to a tearing of the mesotendon at the time of fracture, with a disturbance of blood supply, resulting in necrosis of the tendon fibers and rupture. Lülsdorf reported a case following a fracture with no displacement, and explained the rupture as a result of necrosis from disturbance of blood supply. Axhausen explains the rupture as a result of continual rubbing of the tendon on the sharp bone edges at the fracture site, with a gradual fraying out of the tendon. This, however, does not offer sufficient explanation, for, if this were true, there should be a larger number of late tendon ruptures, since many displaced Colles' fractures are incompletely reduced or not reduced at all.

Scudder states that the extensor tendon may easily be caught by adhesions and that spontaneous rupture may occur a number of weeks later. DaCosta recognizes the possibility of late spontaneous rupture of the extensor pollicis longus tendon, after Colles' fracture, but offers no explanation for its occurrence. Ashhurst reported a case in which the extensor tendon had become densely adherent in the callus, the tendon later rupturing as a result of a strain on it during a strong grasping movement. The proximal end remained attached in the dense callus and the distal end was pulled away.

After reviewing the reported cases and studying this one and the dissected wrists of cadavera, two explanations for late rupture of the extensor pollicis longus tendon following Colles' fracture have been considered:

First, a direct partial severance of the tendon by a sharp edge of bone at the time of fracture, which, not being completely healed during the period of immobilization, leaves a weakened spot and then later a strong exertion upon the tendon causes it to rupture. No case was found reported of complete rupture of the tendon at the time the fracture occurred. It is not difficult to understand how the extensor tendon to the thumb could be injured by a sharp fragment of bone, as it is placed in intimate contact to the radius in the radial groove and is held tightly to the bone by the dense nonyielding transverse carpal ligament. Hence, with the tendon taut, as it is at the time of fracture, a sharp edge of bone projecting posteriorly could partly sever the tendon, the latter being caught between the fracture edge and the transverse carpal ligament. Then, following the period of immobilization, during which the laceration is not sufficiently repaired, a strong exertion upon the tendon causes it to rupture at the weakened spot. This explanation holds in the writer's case and would appear to be the most rational one for the majority of the reported cases, since only a few at the time of operation have revealed other conditions sufficient to account for the rupture. In fact, there is no way of knowing that this condition of partial tendon severance does not occur more frequently with healing of the defect during the period of immobilization and before any severe strain is placed upon the tendon.

Another explanation is considered, as a few of the reported cases of late rupture have occurred following fracture in which there has been little or no displacement of the fracture fragment as in the case reported by Lülsdorf. A possible cause of rupture in these cases is a local tendon necrosis from a disturbance of blood supply, produced by rupturing of the blood vessels in and around the taut tendon at the time of fracture, with the added pressure of the hematoma, or later the callus, to further obstruct the blood supply. Later the tendon may become adherent to the surrounding structures resulting from the hematoma and the callus. With the tendon thus weakened and adherent to surrounding structures, a strong grasping effort, following immobilization, might cause the tendon to separate. Ashhurst described the possibility of the tendon becoming adherent to surrounding structures in the case he reported.

Various immediate causes of late rupture of the extensor pollicis longus tendon have been reported, such as inserting hair pins, peeling apples, making buttonholes, handling dishes, and more strenuous exertions,—as chopping wood.

The only symptom common to all these patients has been the inability to extend the thumb, although a few have stated they felt a "snapping" or "giving way of something" on the back of the wrist. There has been no associated pain with the rupture. On examination there is inability to extend the thumb; the separated tendon ends may be palpated; and there is

FIG. 1

Case 1. Thumb in position of flexion with inability to extend it, due to late rupture of extensor pollicis longus tendon following Colles' fracture.

FIG. 2

Case 1. Colles' fracture with displacement of small fragment of cortex posteriorly, causing late rupture of extensor pollicis longus tendon.

FIG. 3

Case 1. Thumb extended after restoration of function in extensor pollicis longus tendon, following tendon suture eight months previously.

an obliteration of the "snuff-box" from absence of the ulnar-bounding tendon. The diagnosis is easily made on the history and findings.

Treatment is surgical and consists of suturing the divided tendon ends. This may be done with the tendon lying in its normal groove beneath the transverse carpal ligament, or subcutaneously when this is impossible. Failure to approximate the separated tendon ends can be overcome by using some form of tenoplasty. The thumb should be immobilized in a position of extension to release all tension on the tendon, for a period of three to four weeks. Resulting stiffness, if present, is overcome with guarded movements, physiotherapy, and massage.

CASE REPORT

Late rupture of extensor pollicis longus tendon following Colles' fracture: Female, aged thirty-five, was admitted to the University of Chicago Clinics, April 21, 1930, having received a right Colles' fracture in a fall, on March 2, 1930. X-ray pictures revealed a small bony fragment with a posterior displacement. The wrist was kept immobilized for a period of three weeks after the fracture. Following this period the patient was able to extend the thumb, although she used it very little. Then, on April 1, 1930, while using her right hand to insert a hair pin, she suddenly noticed that she could not extend the right thumb. There was no pain, sensation remained intact, and all other motions of thumb, fingers, and wrist were normal.

On examination the right thumb was flexed and the patient was unable to extend it, although all other motions were intact (Fig. 1). There was an obliteration of the "snuff-box", due to absence of the ulnar-bounding tendon. Tendon ends could not be palpated and sensations were normal. A roentgenogram (Fig. 2) shows a small bony fragment displaced posteriorly. Diagnosis of late rupture of the extensor pollicis longus tendon following Colles' fracture was made. At operation, April 22, 1930, under local anaesthesia, the tendon ends were found divided over a sharp prominence on the back of the radius. The ends were somewhat retracted and frayed out, although neither was bound down by adhesions. It was impossible to approximate them beneath the transverse carpal ligament so that they were approximated and sutured with silk subcutaneously. A cast was applied to the hand, forearm, and arm, with the thumb and wrist extended and the elbow flexed. It was removed after three weeks and active motion started gradually. Improvement was steady and three months later the patient had approximately fifty per cent. of normal function. On examination eleven months after the operation, extension of the thumb was normal and all other movements were normal except for slight limitation of flexion of the metacarpophalangeal joint (Fig. 2).

Rupture of the flexor pollicis longus tendon following Colles' fracture, which condition was not found reported in the literature, should be much less likely of occurrence than late rupture of the extensor tendon to the thumb, because of anatomical reasons. The flexor tendon is not in as intimate contact with the radius as the extensor tendon, being separated by the pronator quadratus muscle, except at the distal part of the bone, where it lies in close contact to it. In the case reported here the flexor tendon was found divided at a sharp angulation of the fracture on the volar surface of the radius. Following the period of immobilization, the patient was able to flex the distal phalanx of the thumb, but used the hand very cautiously. Then, three months after the fracture, while chopping wood—the first strenuous work attempted following the fracture—the tendon ruptured. The

explanation for this rupture was a partial severance of the tendon from the sharp fracture fragment at the time of injury, which failed to heal completely. Then, later, during strenuous work, the tendon ruptured at the weakened spot.

CASE REPORT

Late rupture of flexor pollicis longus tendon following Colles' fracture: Male, aged thirty-five, entered the University of Chicago Clinics, April 4, 1929, having received a right Colles' fracture four months previously while cranking a tractor. A large swelling developed on the volar surface of the wrist, but the skin remained intact. X-ray pictures at that time revealed a marked dorsal displacement of the lower fragment. The fracture was reduced, and a splint worn for four weeks. He gradually regained use of the wrist and thumb and apparently was on the road to recovery when three months after the accident, while chopping wood, he suddenly noticed that he could not flex the right thumb. There was no pain. Five weeks after the loss of this motion he came to the Clinic and, on examination, flexion of the distal phalanx of the thumb was absent; however, all other motions were present and sensations were intact. The tendon ends could not be palpated. A roentgenogram (Fig. 4) showed the radius to be fractured transversely near the wrist joint. Diagnosis of late rupture of the flexor pollicis longus tendon following Colles' fracture was made. At operation the flexor tendon was found divided at the level of a prominence on the volar surface of the radius, resulting from the fracture. The retracted proximal end was found and isolated from adhesions. The distal end was so markedly retracted that it could not be found and drawn out of its sheath. A small incision was then made over the front of the first phalanx of the thumb and the tendon isolated. After a hard pull on the proximal end, the adhesions gave way and the tendon was brought out of the wound. A tendon carrier was then passed from the upper wound along the tendon sheath and out through the lower incision. The end of the tendon was sutured to it and drawn upward through the sheath. With the thumb and wrist in flexion, the two ends were sutured with chronic catgut, the wounds closed and a cast was applied to the hand, forearm, and arm with the thumb, wrist, and elbow in flexion. The cast was left on for four weeks after which the patient gradually increased the use of the hand. Figure 5 shows the degree of flexion and of extension possible twenty months after operation. He reported that he had a very useful hand and that the grip on tools with the thumb was practically normal.

FIG. 4

Case 2. Fracture of radius which caused late rupture of the flexor pollicis longus tendon.

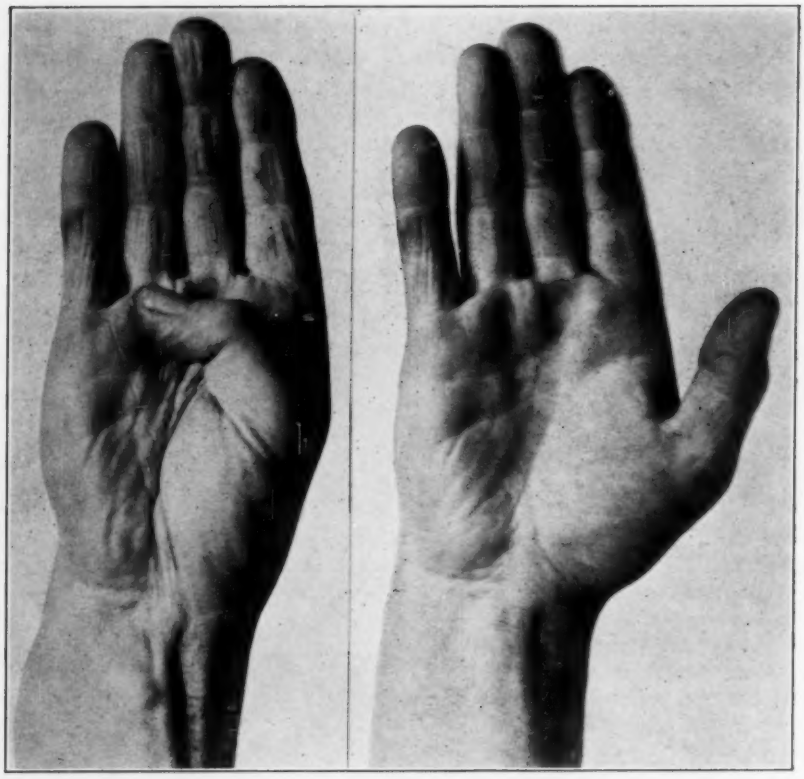

FIG. 5

Case 2. Degree of flexion and extension possible in thumb twenty months after suturing separated ends of flexor pollicis longus tendon.

SUMMARY

1. Wrist tendon ruptures occur following disease processes and trauma, single or multiple.

2. A case of late rupture of the extensor pollicis longus tendon following Colles' fracture is reported, making twenty-eight in the literature.

3. A case of late rupture of the flexor pollicis longus tendon following Colles' fracture is reported. No other reported cases were found.

4. Almost complete restoration of function followed suture of the tendon in each case.

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AN EXPERIMENTAL STUDY OF THE DISTRIBUTION OF THE PERIPHERAL BLOOD FLOW*

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The purpose of this paper is to discuss the results obtained in an experimental study undertaken to determine the manner of the distribution of the blood flow in the posterior extremities of the dog and to what extent it was affected by some of the factors which would seem obviously most influential. No attempt will be made to describe in detail any of the experiments undertaken, but the experimental methods employed will be briefly summarized.

In all experiments change of temperature of tissues was the criterion of change in the volume flow of circulation. Only comparatively rapid changes in the tissues were interpreted as a measure of volume flow of circulation. For example, if the temperature of the foot of the experimental animal is found to remain at thirty degrees, centigrade, during a period in which the temperature of the circulating fluid in the femoral artery is maintained at thirty-nine degrees, and the temperature of the foot changes promptly to correspond with a change in the temperature of the circulating fluid in the femoral artery, it would seem that it were certain that the fluid was flowing through the vascular bed of the foot. On the other hand, if the temperature of the experimental animal's foot remained at approximately room temperature (twenty degrees, centigrade) during a period in which the temperature of the circulating fluid entering the posterior extremity was forty degrees, centigrade, or did not show prompt change in temperature to correspond with relatively gross changes in the temperature of the fluid in the femoral artery, it is obvious that very little or none of the fluid is passing through the vascular bed of the foot.

In one series of experiments the following method was employed. A dog was anaesthetized with morphin and ether. Cannulae were placed in the right carotid and right femoral arteries and the blood pressures in these vessels were recorded with mercury manometers and a kymograph. Mercury thermometers were imbedded in the left foot, left thigh, and rectum. The temperatures of these sites were recorded every five minutes. The abdomen was opened and the aorta carefully isolated sufficiently to apply a screw clamp, which made it possible to constrict the terminal aorta to any desired extent without disturbing the continuity of the experiment.

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The results obtained in this series of experiments were quite different. In some experiments the temperatures of the foot, thigh, and rectum were always depressed by constricting the aorta and quickly rose if the constriction were released. In other experiments alternate obstruction and release of the aorta would cause changes in temperature in the rectum and thigh, but none in the foot. In some instances the temperature of the foot would change relatively more than that of the thigh. In other experiments alternate obstruction and release of obstruction of the aorta would not cause any perceptible change in temperature of the thigh or foot.

In the experiments in which constriction of the aorta caused no temperature changes in the extremity, it was observed that the blood pressure changes in the femoral artery associated with occlusion of the aorta were different from those associated with occlusion of the aorta in those experiments in which tissue temperature changes followed constriction of the aorta. In the former it was impossible to produce a slowly progressive fall in the femoral arterial pressure by slowly occluding the aorta, while in the latter instances gradual occlusion of the aorta was accompanied by a corresponding slow decline in femoral arterial pressure. If constriction of the aorta caused no tissue temperature changes, then during its gradual constriction the femoral arterial pressure was not perceptibly depressed until all evidences of pulse pressure had been obliterated and the aorta was almost totally occluded. Completion of the occlusion of the aorta caused a sharp drop in femoral arterial pressure. If constriction of the aorta did result in marked tissue temperature changes, then with slow constriction of the aorta there was a correspondingly slow depression of femoral arterial pressure and the pulse pressure waves remained in the tracing of the femoral arterial pressure until a low level was reached. From the application of the known principles of lateral pressure in a tube, it would seem as if it must be true that in those experiments in which constriction of the aorta was not associated with tissue temperature changes, there was really very little stream motion in the column of blood in this vessel. In other words, normal blood pressure and normal pulsation in an artery is not a reliable index of the volume flow of blood through this vessel. From these and other experiments we are convinced that a tissue may contain normally pulsating arteries with very little volume flow of blood.

These experiments emphasize the fact that the peripheral blood flow is very unequally distributed to the tissues. We have tried by various methods to influence this unequal distribution of blood, either to change it to a homogenous distribution or to shift the inequalities. Without going into details of these methods it will suffice to say here that the only method which has so far been found effective during the comparatively brief time which any such experiment may be continued is by making use of the vasomotor nervous mechanism. It would seem as if the problem influencing the distribution of the peripheral blood flow would be well on the way to being solved, if it were possible to devise some method of inducing at will the flow of blood through the foot of an experimental animal at

a time when for no apparent reason this part of the body is devoid of any perceptible circulation.

A series of experiments has also been carried out in which the circulation of the posterior extremities of the dog has been maintained by a perfusion pump. Here it is worth while calling attention to the fact that in these experiments, in which the circulation is produced by a perfusion pump, we are dealing with conditions entirely different from those existing in a living animal. The most important differences in the conditions are:—first, the output of the perfusion pump can be accurately controlled; second, the circulating fluid can never be made even closely to simulate normal circulating blood; and, third, the extremities are separated from any influence exerted by the central nervous system or sympathetic ganglia.

The fact that the experimentator has perfect control of the output of the perfusion pump is of course of tremendous importance in the study of the effects of arterial obstruction. In a living animal, obstruction of an artery is always attended by changes which operate to compensate for the obstruction. Since these compensatory changes cannot be controlled, the investigator has no accurate knowledge of how much change he is making in the volume flow of blood through any portion of the body by varying degrees of obstruction of the primary artery supplying this particular portion of the body. If constriction of an artery influenced the cardiac output, it might even happen that partial obstruction of an artery would increase the volume flow of blood in the tissue supplied by this artery. Also, it has been found that a large artery with good pulsation and normal intravascular pressure, which was presumably transmitting a good stream of blood, was in reality nothing more than a pulsating streamless column of fluid. The mechanism of automatic readjustment of the circulation of blood is so extremely complex that it is difficult or impossible to isolate for study any of the various factors concerned. At the present time, therefore, the only accurate method of securing the known output of fluid supplied to any part of the peripheral circulation is by the use of a perfusion pump. The perfusion pump devised by Dale has been used in all of our experiments. This pump is so constructed that the circulating fluid comes in contact with only glass and rubber. The output of the pump can be accurately determined and changed at any time without interrupting in any way the continuity of the experiment. The pump is also equipped for maintaining a constant temperature of the fluid to be perfused, and this temperature may be easily and quickly changed if desired.

The most serious objection to the assumption that changes in the circulation of a living animal produced by some particular cause would be the same as those observed to follow the influence of this particular factor in an experiment in which the circulation was maintained artificially by a perfusion pump, is the fact that it is impossible to maintain the "normal" characteristics of the circulating fluid. In our experiments we have used defibrinated blood, artificial blood made from gum acacia, Ringer's solution, and physiological salt solution. In the experiments in

which blood was used as the perfusion fluid, a satisfactory method was devised of keeping a relatively normal state of oxygen and carbon-dioxid content. In some of the experiments the oxygen consumption was fairly satisfactorily determined. No satisfactory means has as yet been devised of maintaining normal hydrogen-ion concentration. Also, it is obvious that the products of tissue metabolism accumulate in the perfused fluid, and the perfused fluid is probably relatively quickly depleted of the products of any of the glands of internal secretion.

The description of the details of any of the experiments performed will be omitted and only a few of the more important results obtained will be discussed. In each experiment the animal was deeply anaesthetized, bled to death, and the posterior half of the body was separated as rapidly as possible. The blood was defibrinated and used as the perfusion fluid in some experiments. The aorta and the inferior vena cava were connected with the perfusion pump. The lateral pressure and "pulse rate" and pulse pressure in the aorta were recorded with a mercury manometer and kymograph. Mercury thermometers were imbedded in the rectum, thigh, and foot. Thermometers were also placed in the cannulae so as to record the temperature of inflowing and outflowing perfusion fluid. The capacity of the perfusion pump had been carefully calibrated so that the exact amount of its output was recorded. The weight of the posterior half of the body was recorded at frequent intervals. In the experiments in which blood was used as the perfusion fluid, special equipment was included to furnish oxygen and remove carbon dioxid.

The experiments in which the perfusion pump was used were particularly useful in determining the effect of changes in the temperature of the perfusion fluid on the temperature of the tissues of the extremity. In some experiments changes in temperature of the inflowing fluid were followed immediately by corresponding changes in the temperatures of the rectum, thigh, and foot. In other experiments, in spite of gross changes in the temperature of the perfusion fluid, the temperature of the foot would remain stationary or show a change in the opposite direction to that of the change in temperature of the perfused fluid. In other instances the foot seemed to respond more quickly than the thigh.

The results obtained from changing the output of the perfusion pump during a period in which the temperature of the perfusion fluid was kept constant were of particular interest. It was found that changing the output of the pump usually did not influence the distribution of the circulation. If the volume flow of the fluid was increased, it appeared that all of it passed through much the same parts of the extremity which had received the previous smaller volume flow. In other words, it was impossible to force a wider or more homogenous distribution of blood flow by increasing the total amount of volume flow. It was found in some instances that the output of the pump could be increased to an amount certainly in excess of the normal volume flow to the posterior extremities and still apparently have all of the fluid flowing through only that portion

of the vascular bed near the cannulae. In these experiments the muscles of the extremities retained the power of contraction on stimulation and the blood vessels reacted to adrenalin.

The effect of alteration of venous pressure was studied. In general any change in venous pressure was followed by a nearly identical corresponding change in arterial pressure. In this the perfusion experiment differs sharply from the experiments on the living animal. Increasing venous pressure in the living only affects arterial pressure which has already been reduced by arterial obstruction and, as has been previously shown, reduces the volume flow of blood. In the perfusion experiments there was no arterial obstruction and the output of the pump was not changed by increasing or diminishing the peripheral resistance. Usually increasing venous pressure did appreciably change the distribution of the blood flow in the perfusion experiments. In some instances it seemed possible, so to speak, to open a portion of the vascular bed for circulation by increasing venous pressure.

In general it seemed that the experiments with the perfusion pump gave an opportunity for studying the purely mechanical factors of the peripheral blood flow more or less independent of the influence of the vasomotor nerve mechanism. It was interesting to find that, with the extremities in a state of "rest", much the same conditions existed as in the living animals, as far as being able to bring about artificial influence was concerned. The blood flow was unequally distributed and this distribution could not be appreciably changed by any method used.

The experiments briefly described in this paper have been included to illustrate the experimental methods used and to call attention to a few fundamental principles involved in the mechanism of the distribution of the peripheral blood flow. It is not our intention to produce the impression that any of these principles have not been previously recognized, but to discuss the application of certain of these fundamental principles to an analysis of conditions present in abnormal states of the circulation.

The regulation of the circulation is an extremely complex mechanism. The cardiac output, the cross-section area of the entire circulatory bed, the capacity of the circulatory bed of any particular portion of the body, the blood volume, the chemical characteristics of the blood, and the balance existing between the inflow and outflow of blood from all or any particular portion of the body, are factors which are constantly varying through relatively wide limits. Of all the known characteristics of the blood and the blood vascular system, there are only two which apparently remain comparatively constant,—the chemical constitution of arterial blood and the intravascular pressure in the large arteries.

In discussing the distribution of the peripheral circulation, the fact that the blood pressure in the abdominal aorta remains so remarkably constant is of great importance. This fact is emphasized in all of our experiments in which the abdominal aorta was wholly or partially occluded. Occlusion of so large an artery so near the left ventricle must produce an

enormous change in relative cross section area of the circulatory bed and would, therefore, be expected to produce a marked change in the blood pressure proximal to the constriction. As a matter of fact, there is but a slight momentary change and the heart and the unobstructed circulatory system adjust conditions so as to retain a "normal" pressure in the base of the aorta.

With a constant blood pressure the volume flow of blood through any particular portion of the body—as, for example, an extremity—is necessarily dependent on the total cross-section area of the smallest portion of the circulatory bed of the extremity. If all the communications between the arteries and veins were the same size and offered the same resistance, the flow of blood would be homogenously distributed. As a matter of fact, however, this is just the condition which is not present in the "normal" state. For example, Blalock has shown that during contraction of a muscle the flow of blood is not only completely stopped, but also that the blood already in the arterioles is actually forced back in the artery supplying the muscles. The experiments described in this paper show that it is possible to have a large volume flow of blood through the extremities with certain portions of these extremities having no evidence of any blood flowing through. It is worth repeating that this condition may be present with good pulsation in the arteries actually in the area devoid of demonstrable blood flow.

It follows therefore that peripheral blood flow is not homogenously distributed and we wish to discuss particularly the factors which influence this unequal distribution.

The actual amount of blood which flows through any particular channel connecting an artery and a vein is obviously dependent on difference in intravascular pressure between the artery and the vein and the size of the channel. In health the arterial pressure remains remarkably constant. The size of the channel is known to be influenced by the vasomotor nerves. The phenomenon of opening and closing of capillaries has been clearly demonstrated by Krogh. The venous pressure is influenced by the massaging action of muscle contraction with the action of valves of the veins. The fact that hydrostatic pressure must influence distribution of blood must be accepted. The volume flow of blood in any particular area must therefore be determined by the influence of the vasomotor mechanism and by mechanical conditions not associated with vasomotor phenomena. In the normal individual the influence of the vasomotor mechanism undoubtedly predominates, and there is, so to speak, constantly changing irregular or unhomogenous blood flow which is normal. In fact it has been pointed out in a previous communication that an actively irregular and changing distribution of peripheral blood is a characteristic of the normal state. The static, regular, unchanging distribution of peripheral blood flow is abnormal.

The capacity of the vasomotor mechanism to regulate the peripheral circulation is seemingly adapted to certain limits of total blood flow and

capacity of the blood vessels, and, if the conditions are such as to be without this limit, then the vasomotor mechanism becomes inadequate or inefficient and the influence of mechanical factors, not a part of the vasomotor mechanism, predominates.

This idea is suggested in comparing the results obtained in experiments in which the total volume flow of blood through the posterior extremities was varied by partial occlusion of the aorta with those obtained by perfusion of the posterior extremities which had been completely severed from the central and sympathetic nervous systems. The temperature fluctuations in the tissues which resulted from changing the temperature of the inflowing fluid and the output of the pump were usually those which would be expected from the nature of the mechanical changes. With compression of the aorta the effect could not be predicted. In other words, the circulatory bed without vasomotor control behaves similar to a system of lifeless tubes. Also it is well known in clinical medicine that an extremity in which there is marked arterial obstruction shows very marked effects of changes in simple mechanical conditions. It becomes bloodless on elevation and engorged with blood if depressed. The well known curative effect of elevation of the extremity with varicose ulcers is another example of the application of the influence of pure mechanics on the distribution of blood flow. In several instances of sudden arterial occlusion we have felt convinced that the vitality of the extremities has been preserved for periods of one to three days by frequently alternating elevation and depression.

The regulation of the peripheral blood flow is an extremely complex mechanism even if isolated from the complex mechanism of the action of the heart. Although in last analysis blood flow is a purely mechanical process, the mechanism of control is extremely complex. It is influenced by nerves and hormones, but is also influenced by purely mechanical factors. With marked abnormalities, consideration of these mechanical factors may become important. There has been a great deal of study of the problems of total blood flow. The distribution of the blood flow in peripheral circulatory bed has not been extensively studied. Attempts to "*improve the circulation of the extremity*" undoubtedly involves more than an attempt to influence the total amount of volume flow of blood delivered to or returned from this extremity.

THE EFFECT OF INSULIN ON THE HEALING OF EXPERIMENTAL FRACTURES IN THE RABBIT*†

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The utilization of insulin to attempt to accelerate the rate of healing of fractured bones has received scant attention so far. For several years it has been known that the local and general application of insulin to diabetic and non-diabetic ulcers has stimulated healing, has hastened the proliferation of epithelium, and has produced early cicatrization of wounds [1,2,6,10,13,19]. It has also been noted, over and over again, that injections of insulin into animals affect markedly the metabolism of calcium and phosphorus. Hence, this experiment was undertaken in the hope that a practical clinical application might be discovered whereby insulin could be used in combating the growing problem presented by delayed union of fractures. I was aware, however, that the employment by other observers of many chemical and glandular substances, known to alter the concentration of calcium and phosphorus in the blood, had failed to accelerate appreciably the healing of fractures. Injection of parathormone[15], administration of irradiated ergosterol [12,14,17,21,23], or feeding of calcium or phosphorus [9,18,22], or both, have not produced tangible increase in the formation of callus or in the rate of healing of bone.

METHOD

In my experiment, normal adult laboratory rabbits, which averaged two and four-tenths kilograms in weight, were used. Males and females were about equal in number. All animals received the normal laboratory diet, which contains adequate amounts of all required food factors. Open osteotomy of the left fibula, by standard method, was performed on all. Under ether anaesthesia, and with the usual aseptic precautions, an anterolateral incision was made in the left leg, the upper third of the fibula was exposed, and the bone was fractured by twisting it with a hemostat. The wound was then sutured in layers, and a collodion dressing applied. This type of fracture was selected because, in the rabbit, the fibula is fused distally with the tibia for more than half its length and proximally it is firmly united with the head of the tibia by the interosseous ligament (Fig. 1). Thus, it was possible to produce a uniform type of fracture, there was a minimal chance of displacement and of motion, and external splinting was not necessary.

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†Abstract of thesis submitted to the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Orthopaedic Surgery.

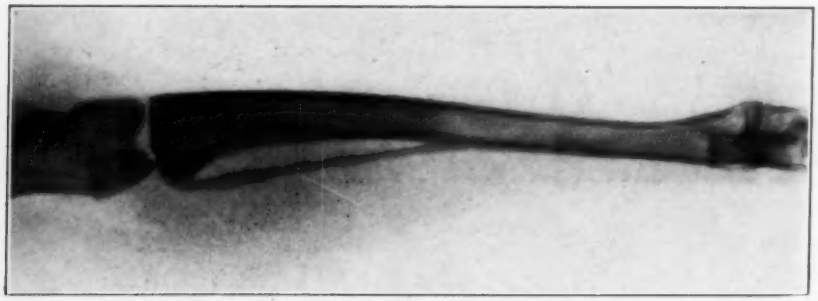

FIG. 1

Rabbit's leg twenty-six days after operation. The relative shortness of the fibula in this animal, its secure attachments proximally and distally, and the type of fracture which was performed in this experiment are evident.

The operation was performed on fifteen normal rabbits used as controls, two of which died from the anaesthetic at operation, and two others died of intercurrent disease in the course of the experiment. The remaining animals were killed at intervals varying from nine to sixty-two days after operation. The relatively low mortality—as experiments on rabbits go—probably was due to the absence of external splints and to the minimal injury to tissue involved in the operation.

Fifteen similar animals were operated on in identically the same way and their subsequent care was the same, except for the injections of insulin. In this second group, daily intravenous injection of insulin, in the lateral vein of the ear, was commenced immediately after operation. Iletin was used, and the animals received one and five-tenths units for each kilogram of body weight daily at about two in the afternoon. None of the animals died at operation; five died from reactions to insulin in the course of the experiment. The remainder were killed at intervals corresponding to those at which the control animals were killed.

At first, roentgenologic examination of the fractured bone of representative animals from the control group and from the group receiving insulin was made weekly. This method was later abandoned, however, because there was no detectable difference in the progress of healing between the animals of the two groups. Microscopic studies were undertaken as the animals died or were killed. Bone from the site of fracture was decalcified in hydrochloric acid (4 per cent.), sectioned, and stained with hematoxylin and eosin; then comparisons were made in the rate of healing of bone from animals in the two groups.

RESULTS

In the majority of cases, comparison between the sections, taken through the fractures at similar periods of time after operation, of the normal control rabbits and of those which had received daily injections of insulin, revealed a tendency to more advanced healing in the insulinized

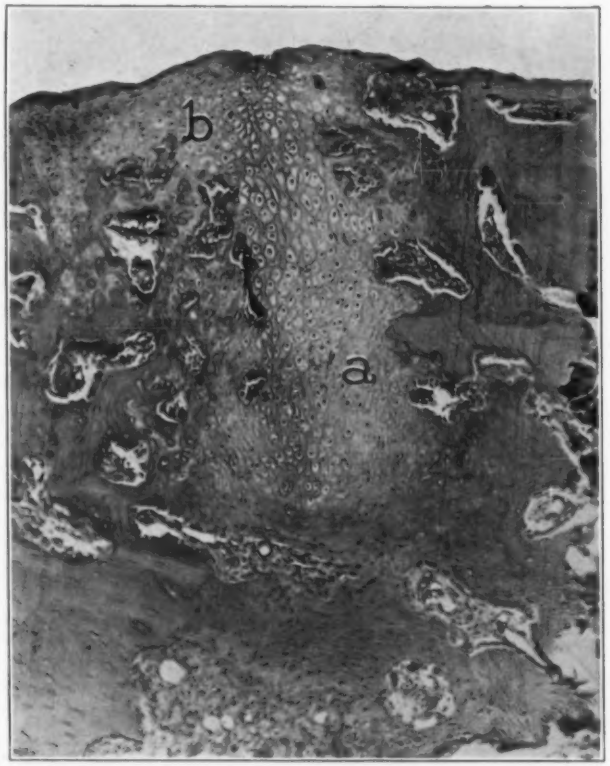

FIG. 2

Fracture in normal animal twenty-three days after operation. In the line of fracture at *a* there is considerable osteoid callus between the medullary canals. At *b* there is a very slight amount of provisional callus in which there is beginning calcification. This should be compared with Fig. 3. (× 50)

FIG. 3

Fracture in insulinized animal twenty-four days after operation. In the line of fracture at *a* there is almost complete calcification between the trabeculae of the medullary canals. No osteoid tissue is present. This should be compared with Fig. 2. (× 40)

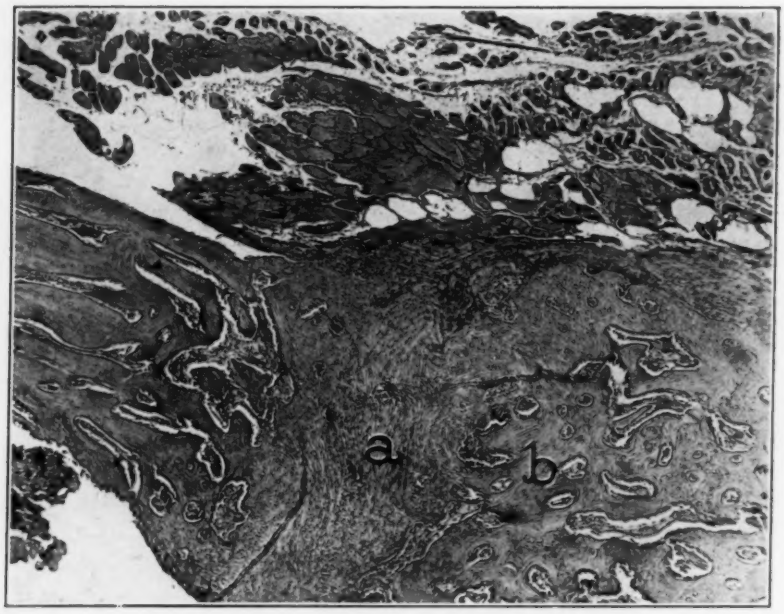

FIG. 4

Fracture in normal animal thirty-three days after operation. In the line of fracture at *a*, there is calcification of transverse callus with regression of chondroblasts. Occasional osteoid cells are seen at the margin of the medullary bone (*b*) and callus. This should be compared with Fig. 5. (× 40)

animals. The steps in the process (hemorrhage, reorganization of the clot, proliferation of osteoblasts, calcification, and so forth) seemed to be identical in the two groups, and the amount of reaction between the ends of the bone seemed to be the same. But the process of healing seemed to be relatively more advanced in the insulinized animals in relation to the time after operation.

For instance, Figure 2 represents a specimen from a normal animal twenty-three days after the fracture. At the line of fracture (*a*), there is moderate amount of osteoid callus between the medullary canals of the ends of bone; calcification has begun but has not progressed markedly. At *b*, the subperiosteal provisional callus is calcified and there is beginning regression of the chondroblasts.

On the other hand, in Figure 3, which represents a specimen from an animal that received insulin twenty-four days after operation, there is total absence of osteoid callus between the ends of bone. Apparently the calcification at the line of fracture (*a*) has passed the osteoid stage and the rearrangement of trabeculae is now ready to begin. There is no obvious difference between the type of bone in these two healing fractures, and the only difference seems to be in the progress of the process of healing.

Considering the material from another angle, it was found that by selecting sections from each group which seemed to be at similar stages of

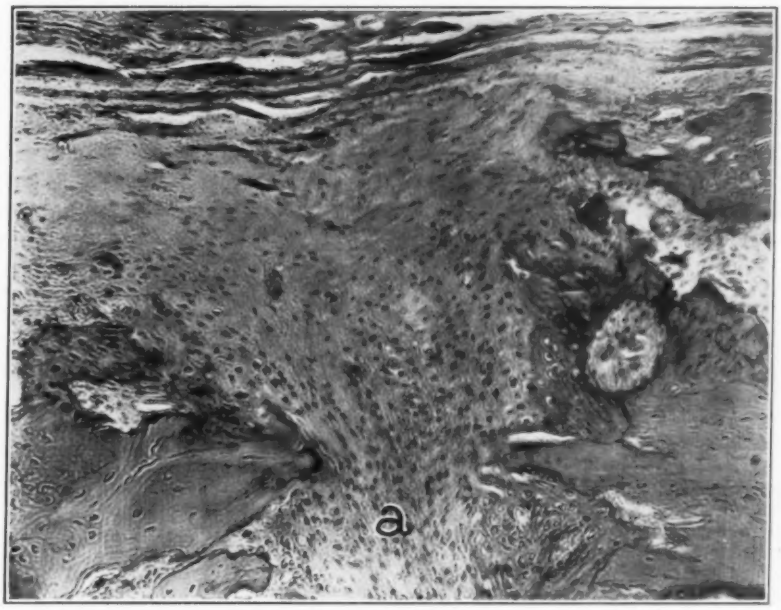

FIG. 5

Fracture in insulinized animal twenty-two days after operation. In the fracture line at *a*, there is almost complete calcification of intramedullary callus. The ends of bone are firmly united. This should be compared with Fig. 4. (× 70)

healing, the difference in time after operation between the normal control animals and those which had received insulin was even more marked. The sections in Figures 4 and 5 seem to be identical so far as healing is concerned. In each, the calcification of osteoid callus is complete, except for the presence of a few scattered chondroblasts near the juncture of the normal medullary bone, and the new calcified callus. In each of these two sections retraction of the subperiosteal provisional callus is the same. In neither is there any evidence of beginning rearrangement of the trabeculae to assume the normal longitudinal arrangement. Yet Figure 4 represents fracture in a normal control animal thirty-three days after the operation and Figure 5 represents fracture in the insulinized animal twenty-two days after operation.

In those fractures examined two weeks or less after operation, the difference in progress of healing was very slight, and, if there was any precocity, it occurred consistently in the insulinized animals. Likewise, after four weeks, the final stages of healing in the two groups of animals seemed little different. In other words, the variations in the progress of healing, slight though they were, were detectable only in the group of animals which were killed in the second to the fourth week after operation. And this difference, which was entirely microscopic, was principally manifest as earlier calcification of callus in the insulinized animals. It was not possible to determine the relative solidity of bony union in the two groups, but to all appearances, gross and microscopic, it was identical.

COMMENT AND SUMMARY

In the year that insulin was isolated, Fiske first called attention to the decreased output of urinary phosphates after ingestion of sugar by normal persons. Blatherwick, Bell, and Hill administered insulin to normal persons and noted that there was marked decrease in the inorganic phosphorus content of the blood plasma. The same phenomenon was observed in rabbits by Wigglesworth and his coworkers, and in normal dogs by Briggs, Koechig, Doisy, and Weber. In addition to the constant observation of a lowered value for blood phosphates after injection of insulin, many observers have noted a concomitant rise in the value for serum calcium. Davies injected insulin into rabbits and found a marked rise in concentration of serum calcium. Brougher found elevation of blood calcium for a period of two and a half hours in normal and parathyroidectomized dogs, and Ellsworth also noted that administration of glucose and insulin to human beings caused reduction for two to four hours in the value for blood phosphorus and a rise in the value for total blood calcium.

The only previous study of the possible relationship between insulin metabolism and the growth of bone was performed by Schazillo and Ksendsowsky in 1928. They fractured the legs of rats and administered to them non-toxic doses of insulin and calcium chlorid. They estimated the rate of healing by the density of the roentgenologic shadow, and, by this rather gross means of observation, they felt that they could demonstrate a more intense formation of callus at the site of fracture of insulinized animals.

In my experiment with fracture of the fibula in the rabbit, calcification of the callus between fourteen and twenty-eight days after operation seemed to be slightly more advanced in those animals which received daily injections of insulin than in the control animals. This difference was not detectable grossly; yet it was definite when the site of fracture was examined microscopically.

Recently, Leriche and Policard, in their monograph on physiology of bone, have outlined the healing of fractures as an essentially local process involving local vascular changes and redistribution of calcium. My work seems to confirm the conclusion of these investigators; it apparently has no clinical application.

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A DIAGNOSTIC SIGN IN EXAMINATION OF AFFECTIONS OF THE SACRO-ILIAC JOINT; CHAIR TEST

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The following clinical test is suggested as an examination for sacro-iliac conditions, particularly when there is a question of injury or the actual existence of pathology.

The patient, who is standing before an ordinary chair firmly held, with the surgeon extending the hand for the patient to grasp, is asked to step up into the chair. It is surprising how many patients accomplish this act with the attention centered on the up-stepping leg which naturally seems to be the one in which the examiner is interested. With the direction then to step down, the surgeon, still holding the hand, exercises a slight push through the forearm so that the patient steps down unexpectedly, producing a very slight jar which is transmitted upward through the weight-receiving extremity. The surgeon then changes his hand upon the chair and extends the other, repeating the procedure with the opposite leg of the patient.

The test has several interesting features. Patients who are uncooperative in many tests seem to have an interest in this. The chair being large and firm gives a sense of security and the aid given by the surgeon's hand adds to the feeling of confidence. Practically all patients can accomplish this effort and, without instructions, the patient invariably puts the best foot forward, which means he steps up with the leg which has the best hip joint, the best psoas, or the best glutei. Further, the patient's attention is concentrated on the up-stepping leg and without attention to the after-coming extremity.

In this test, when the patient stands upon one foot, the muscles of the leg and the thigh are engaged in maintaining balance. The abductors and extensors of the hip joint (the glutei and the hamstrings), inasmuch as their insertions are fixed and their origins are movable, act very powerfully in this reverse direction to fix the pelvis in respect to the femur and even incline it somewhat so as to bring the center of gravity nearer to the weight-bearing hip. The spine assumes a balancing scoliosis position, convex toward the weight-bearing side, which is accomplished in part by the opposite psoas which is acting to flex the opposite thigh. Since the Y-ligament is a sufficient antagonist for the glutei, the psoas on the weight-bearing side is comparatively relaxed.

In this position, all the weight of the body, including that of the opposite lower extremity, is transmitted to the weight-bearing leg through the sacro-iliac joint on the weight-bearing side. It is under such conditions that only minimal, if any, musculature is available as a protective medium to the ligaments of the sacro-iliac joint.

Until the up-stepping foot is placed upon the chair, the weight-bearing sacro-iliac joint is under condition of pressure and of sheer. This sheering stress is greatest when the pelvis is nearest to the horizontal plane, and lessens with corresponding increase of the factor of pressure the more the pelvis is inclined, for this position makes the weight-bearing more direct from the sacrum to the ilium. The muscles of the up-stepping extremity are at a complete disadvantage, and, before they can be of assistance, a definite upward push must be made by the weight-bearing leg. When the push occurs, considerable inertia of the body is overcome, but not without definite pulsion of the ilium upward, increasing the sacro-iliac sheer. Until the after-coming foot has risen several inches from the floor, the up-stepping extremity has done no real propulsive work, but is in the status of recovery in readiness for the effort. It then assumes all the work and the relaxed after-coming extremity returns to its usual hemi-weight-bearing function and the sacro-iliac joint is then relieved of the unusual mechanical stress.

If the patient steps down with the foot which was last placed in the chair, the weight is received by that extremity with a slight but definite shock, which increases the sheering stress of the sacro-iliac joint on that side,—a down-coming shock, wholly passive, whereas the up-going one is due to muscular effort.

With *bona fide* joint trouble, the patient can hardly be expected to perform this test without complaint. If the surgeon will keep in mind the above outlined physiological mechanisms, he will discover that the sacro-iliac malingerer will step down hard on the foot of the "affected side" without pain.

THE USE OF AUSCULTATORY PERCUSSION FOR THE EXAMINATION OF FRACTURES

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In certain fractures, auscultatory percussion may be employed as a rapid, painless, and always available indicator of the relative position of the fragments and, at a later period, as a method of determining the extent of bony consolidation. This test is of utility chiefly in fractures of the shaft of the femur, humerus, and clavicle to supplement roentgen-ray examination, as a substitute for it when x-ray facilities are unavailable, and to replace it when x-ray and fluoroscopy are inadequate or inapplicable. Conditions such as the latter are common,—particularly in the treatment of femoral-shaft fractures; so that, even in the proximity of complete x-ray equipment, auscultatory percussion can render great assistance to the fracture surgeon.

A search of the literature reveals only the most cursory application of sound phenomena to the examination of fractures. Stewart's surgical textbook mentions that, if one end of a fractured bone is percussed and a stethoscope applied to the other, the sound may fail to come through.[1] In discussing fracture diagnosis, Stimson writes, "Auscultatory percussion, the stethoscope being moved from one fragment to the other while percussion is made upon the first, will sometimes give a marked change in the sound as the line of fracture is crossed; but it is rarely significant, except in cases in which the diagnosis can be made by other means".[2] I have been able to discover no further development in the interpretation or application of the method.

If auscultatory percussion is applied across two bony prominences separated by a long bone, the sound heard through the stethoscope has a characteristic "osteal" quality and is loud, high-pitched, and moderately resonant. While to some extent this sound is modified by body structures in the neighborhood of the examined area, the osteal quality always predominates and is directly attributable to the vibration of the bone in response to the percussion impact. Its loud volume is due to the excellent transmission of sound waves by the bony structure*.

*It is possible to demonstrate the remarkable sound conduction through the skeleton by applying a tuning fork over some bony prominence of the body, a stethoscope at a remote point where the skeleton is superficial, and comparing the volume of the auscultated sound with that obtained when the instruments are applied the same distance apart over deep soft tissue. The striking difference in conduction properties so elicited indicates that when auscultatory percussion is applied from one bony prominence to another, the course of the sound waves lies chiefly through the intervening bone, and only in small part through the soft tissue.

The sound lost on crossing normal articulations is small in amount. This may be demonstrated by comparing the sound elicited by auscultatory percussion through a joint—such as the hip or knee—, which is ankylosed by bone, with that through the opposite normal joint. While easily detectable, the difference in volume is not as marked as might be expected.

FIG. 1-A.

FIG. 1-B.

Case 1 of four, successive femoral-shaft fractures in the reduction of which auscultatory percussion assisted in securing end-to-end apposition.

FIG. 1-A Case 1. On admission. FIG. 1-B Case 1. After reduction.

A fracture lying between the percussed area and the stethoscope produces a change in the character of this sound which is readily perceptible by comparison with that elicited over corresponding points on the normal side. This change, which may be described in terms of intensity, quality, and pitch, constitutes the criterion of the test.

The change in sound character caused by fracture depends upon two distinct and separate mechanisms. Primarily, the quality and pitch of the note produced by the original impact is altered. Percussion of an intact bone causes it to vibrate with a frequency and character corresponding to

its elastic properties as a solid unit. Each fragment of a fractured bone, on receiving the stimulus, vibrates as a separate unit. Owing to its smaller size and altered shape compared with that of the intact bone, the frequency and character of the vibrations are correspondingly changed and a different sound produced. Generally, this sound is less resonant, of indeterminable pitch, and approximates that heard over soft tissue. Secondarily, the conduction of this sound through the bone shaft to the place where the stethoscope is applied may be blocked at the site of fracture and the audible volume so diminished. This diminution varies with the relative position of the fragments. If there is perfect position, the sound waves are transmitted across the fracture almost as well as across normal bone. If slight

FIG. 2-A
Case 2. On admission.

FIG. 2-B
Case 2. After reduction.

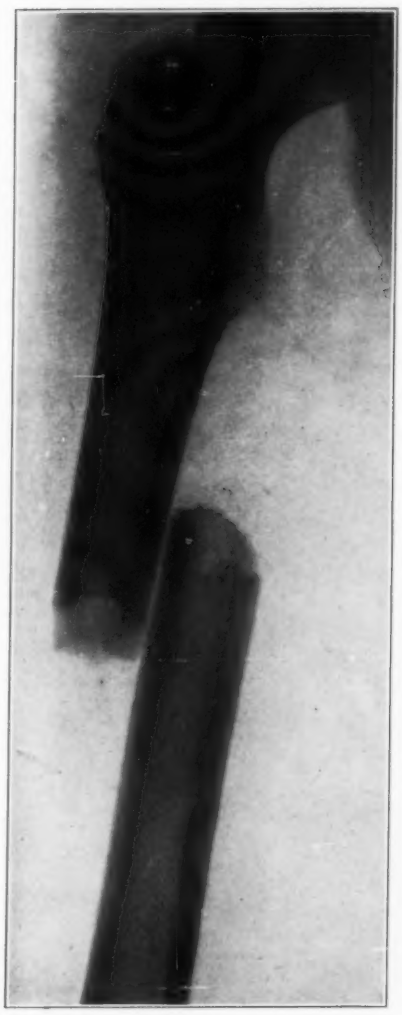

FIG. 3-A
Case 3. On admission.

FIG. 3-B
Case 3. After reduction.

displacement is present, but end-to-end contact persists, more sound will be lost due to the inability of the waves to cross the fracture site in their entirety. Entire absence of end-to-end contact entails practically complete loss of sound transmission, due to reflection of the waves as they pass through media of different density.† Overriding with side-to-side contact effects practically as complete an obstruction to sound as does wide separation between the fragments. In general, it may be emphasized that pitch and quality changes are dependent upon the free vibration of each separate

†"Sound waves may be reflected backward toward the direction from which they came. This is especially apt to occur when vibrations pass through tissues of different densities." (See Bibliography[7].)

fragment. These changes may be detected following complete fractures, regardless of the position of the fragments, and they persist until union is firm. On the other hand, diminution of sound intensity depends solely upon poor conduction through the fracture area. It is not appreciable unless end-to-end contact is absent.

The clarity with which these phenomena may be elicited varies with the location and the type of the fracture. The femur, humerus, and clavicle, which constitute single osseous connecting links, are best adapted to examination of this character. It is feasible to examine the double-boned forearm and leg by auscultatory percussion, but the two bony sound paths available may cause difficulty in determining to which bone the acoustic signs refer. Such examination is seldom of clinical value, unless x-ray facilities are not at hand. Auscultatory percussion of the small long bones of the hand and foot rarely yields satisfactory results. The fracture to be

FIG. 4-A
Case 4. On admission.

FIG. 4-B
Case 4. After reduction.

examined must lie between superficial bony points and must be complete. As a rule, green-stick, incomplete split, and firmly impacted fractures will not furnish acoustic evidence of their presence. Badly comminuted fractures will conduct sound best when in best position, but, even then, the volume is hardly comparable with that obtained through normal bone.

The technique of examination is extremely simple and requires little explanation. The percussion impact should be light but sufficiently strong to produce a clear distinct note on the normal side, and the stethoscope bell should be small so that it can be accurately applied over irregular surfaces. Convenient prominences for auscultation and percussion may be chosen even though joints lie in the sound path. Passage through normal joints does not cause any material alteration in sound quality, and the small decrease in sound volume is similarly manifested between corresponding points on the normal side. For example, when the humerus is examined, the olecranon may be percussed and the stethoscope applied over the acromion. The femur may be examined from the patella to the anterior-superior spine of the ilium and the clavicle from its acrominal end to the sternum. If more direct comparison between both sides is desired, the stethoscope bell may be centrally applied over the sternum (for the humerus), and over the pubes (for the femur), and held there by an assistant, so that both hands of the examiner are free for alternate bilateral percussion.

In suitable cases, auscultatory percussion may be employed for the purpose of diagnosis, as a guide in the process of reduction, as a sign to detect subsequent "slipping", and eventually, as a test of healing.

As an aid in diagnosis, the test is valuable because it furnishes a painless and rapid means of determining whether the suspected fracture is complete and whether the fragments are in end-to-end contact. Even in the superficial clavicle, hematoma and tenderness at the site of injury cause difficulty in ascertaining these facts by inspection and palpation. Alteration in pitch and quality of the note elicited by auscultatory percussion denotes complete fracture. If the intensity is not appreciably decreased, it may be immediately assumed that end-to-end contact is present and that any apparent deformity is due to angulation or hematoma. Decrease of intensity signifies displacement. With the help of this information, so easily and rapidly obtainable, treatment often may be expedited.

The employment of auscultatory percussion to guide fracture reduction is of greatest value in fractures of the shaft of the femur, because the depth of the overlying tissue in this area precludes palpation of the bone. In these circumstances, quality and pitch changes are neglected, and relative sound intensity serves as the only important criterion. When the fragment ends abut each other, sound transmission is good and becomes increasingly better as perfect position is approached. Exigencies of the individual case, as well as the variety of treatment methods in current use for such fractures, would render valueless the enunciation of any universal routine examination procedure. The test may be equally well employed with fracture table and with any manner of Balkan frame technique and, if correctly interpreted,

can serve to indicate immediately whether or not the fracture has been reduced.

As an indicator of "slipping", the test is especially helpful in femoral shaft fractures, and may be daily applied as a routine measure during the first few weeks of the postoperative course. Decrease in sound intensity elicited during this time by auscultatory percussion signifies loss of good position or "slipping". When the injured member is encased in plaster, two one-inch holes cut directly over the anterior-superior spine and the patella will not interfere with immobilization and will provide sufficient access for percussion and auscultation. The plaster will not affect bony sound conduction, if care is taken to prevent it from touching the percussing finger and stethoscope bell during the examination.

Progress in the development of bony union may be tested by applying the same technique at greater intervals during the postoperative course. Normally, the sound character observed after reduction gradually improves, so that, when consolidation is complete, it is indistinguishable from that elicited on the opposite side,—even when the fracture has healed with some

FIG. 5-A

Equivocal x-ray after two months of immobilization. Auscultatory percussion applied at this time indicated that union was incomplete.

FIG. 5-B

Incomplete union demonstrated by x-ray two and one-half weeks later, after attempted weight-bearing.

overriding or angulation. Persistence of perceptible alteration in pitch, quality, or intensity signifies incomplete consolidation. Whether a negligible degree of union can transmit sound waves as well as normal bone remains to be determined. One of the femoral shaft fractures examined by this method resulted in delayed union despite excellent position. After two months of immobilization, x-ray evidence was equivocal (Fig. 5-A). Clinically, the femur appeared solid and capable of weight-bearing. The true condition, however, was suspected by the alteration in the pitch and quality of the transmitted sound and was clinically demonstrated several weeks later by pain, angulation, and false motion after a short time of weight-bearing (Fig. 5-B). Further experiences of this nature must be awaited.

SUMMARY AND CONCLUSIONS

Auscultatory percussion applied across fractures of the shaft of the femur, humerus, and clavicle may be so interpreted as to indicate the presence of a complete fracture, the relative position of the fragments, and, during the postoperative course, the development of bony union. The stethoscope bell and the percussing finger should be applied over bony prominences on either side of the fracture and the sound so elicited compared with that produced by the same procedure on the normal side. Sound alteration constitutes the criterion of the test. Pitch and quality changes result from free vibration of the separate fragments and, accordingly, signify complete fracture or incomplete union. Appreciable diminution in sound intensity indicates poor conduction and reflects absence of end-to-end contact. The chief merits of the examination method may be summarized as follows:

1. The application of the test is simple, rapid, and entails no discomfort to the patient.
2. The desired information is immediately obtainable.
3. For diagnostic purposes, the test is always available when x-ray facilities are not at hand.
4. In the hospital, it may be employed equally well with the patient on the orthopaedic table, in traction apparatus, in bed, or in a plaster cast, and is consequently applicable during, as well as following, the reduction.
5. For certain purposes, the method appears more accurate than x-ray or fluoroscopy.
   A. The presence of end-to-end contact may be established with certainty by auscultatory percussion whereas, with x-ray, the true displacement often appears magnified or reduced. (Distortion due to oblique exposure.)
   B. Determination of the degree of bony union attained is sometimes difficult with x-ray, particularly when plaster or overabundant callus obscures the fracture area. Auscultatory percussion is in no way affected by these factors.

A diversity of other orthopaedic measures entails the sometimes difficult task of determining the presence of bony contact or bony joint fusion. In general, when the test is applied in such cases, its interpretation will follow the above outlined basic principles. The practical utility of the method in this field is being studied at the present time.

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SURGICAL APPROACH IN OLD POSTERIOR DISLOCATION OF THE ELBOW

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Old posterior dislocation of the elbow joint is a common surgical condition in China. Due to the lack of hospitals and modern surgical methods, patients suffering from the condition often go untreated while others come under the care of Chinese barbers—long recognized as the official bone-setters of the country—or are treated by local native practitioners with various kinds of splinting, massage, or manipulation that are not only ineffective but often harmful. As a result, these patients eventually arrive at the hospital clinic with badly traumatized stiffened arms that are locked in a position either of complete extension—since this is the cosmetic position of choice among the Chinese laity—or with the affected elbow held at an obtuse angle with only a few degrees of residual motion.

The clinical picture is usually unmistakable, the only question being one of possible associated fracture. In cases of long standing without concomitant fracture, the x-ray often shows the formation of callus along the posterior surface of the lower end of the humerus where the periosteum has been separated from the cortex. This same condition may be present along the anterior aspect of the dislocated joint, but is more rare.

The reduction of these old dislocations by operation is, of course, clearly indicated, the closed method being reserved as a rule for cases of less than three weeks' standing. Much harm can be done by forced manipulation of these dislocated joints, and the exercise of brute force in attempting reduction is to be condemned. The ideal method of treating these old dislocations of the elbow is the one that will secure reduction with the least amount of trauma, and with the surest guaranty of maximum function. It was with this aim in view that the operative procedure here described was devised.

The operation was first performed by the writer in the Peking Union Medical College Hospital, China, in 1926, and subsequently upon five Chinese patients whose case reports are appended. The short series of cases was unfortunately concluded because of the writer's return to America.

TECHNIQUE OF THE OPERATION

With the elbow flexed over the patient's chest, a posterior median incision is made from the tip of the olecranon proximally for a distance of five inches. The skin and subcutaneous tissues are divided, exposing the lower end of the triceps muscle and its tendon. Hemostasis is carefully observed.

FIG. 1

Posterior skin incision, exposing the lower end of the triceps muscle and tendon. The ulnar nerve has been isolated and is being gently retracted by a saline-moistened tape.

FIG. 2

Division of the triceps tendon with its lateral muscular expansions at a level one-half inch above the tip of the olecranon.

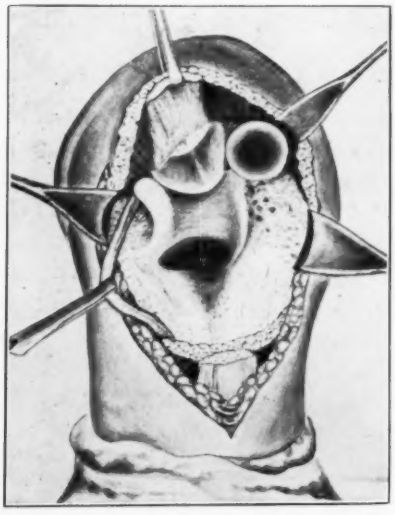


FIG. 3

Exposure of the flexed dislocated joint posteriorly. Callus, fibrous tissue, and adhesions have been carefully removed without traumatizing the articular surfaces. Reduction of the dislocation can now be readily accomplished.

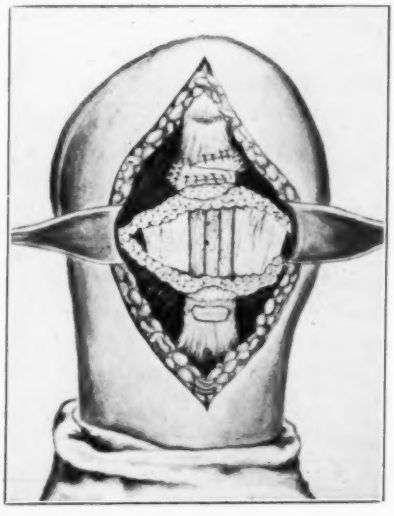


FIG. 4

A strong strip of tendon or fascia lata is sewed through the cut ends of the triceps tendon, elongating it, as required, and acting not only as a connecting link, but as a living graft.

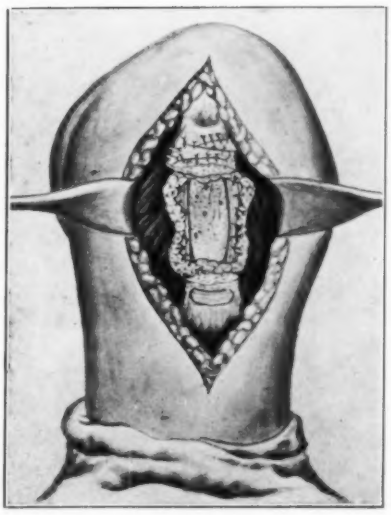


FIG. 5

The triceps muscle expansions are first approximated to the tendon transplant.

FIG. 6

The two strands of transplanted tendon or fascia lata are then sewed together in the mid-line.

The ulnar nerve is then exposed and gently retracted from the wound by means of a saline-moistened tape (Fig. 1). The triceps tendon with its lateral muscular expansions is next divided transversely by one sweep of the knife at a point one-half inch above the olecranon tip (Fig. 2). This opens up the space containing fibrous and scar tissue, torn capsule, organized hematoma, callus, and new bone, all of which must be carefully removed without damaging the normal bone structures. Especial care is taken not to injure the articular surfaces of the humerus, radius, and ulna. After all of the joint structures have been well defined posteriorly, the forearm is gently flexed, bringing into view whatever adhesions are present, and these, as well as any resistant structures, are divided as the forearm is gradually brought into acute flexion (Fig. 3).

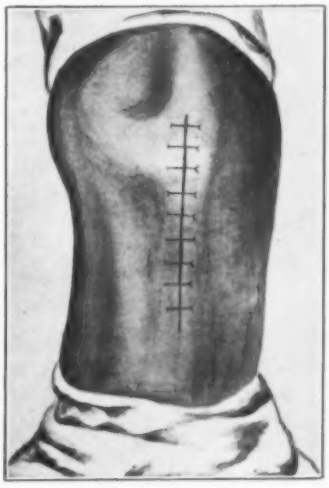


FIG. 7

Closure of the wound while the arm is held in a right-angle position.

Having freed the dislocated joint of all adhesions, any lateral displacement is now remedied, before the usual classical reduction manipulation is carried out. This is performed without force or injury to cartilaginous surfaces, particular care being taken to protect the coronoid process of the ulna. There should be no forceful stretching or levering of structures and no tearing of soft parts. If reduction is not easy upon the first attempt,

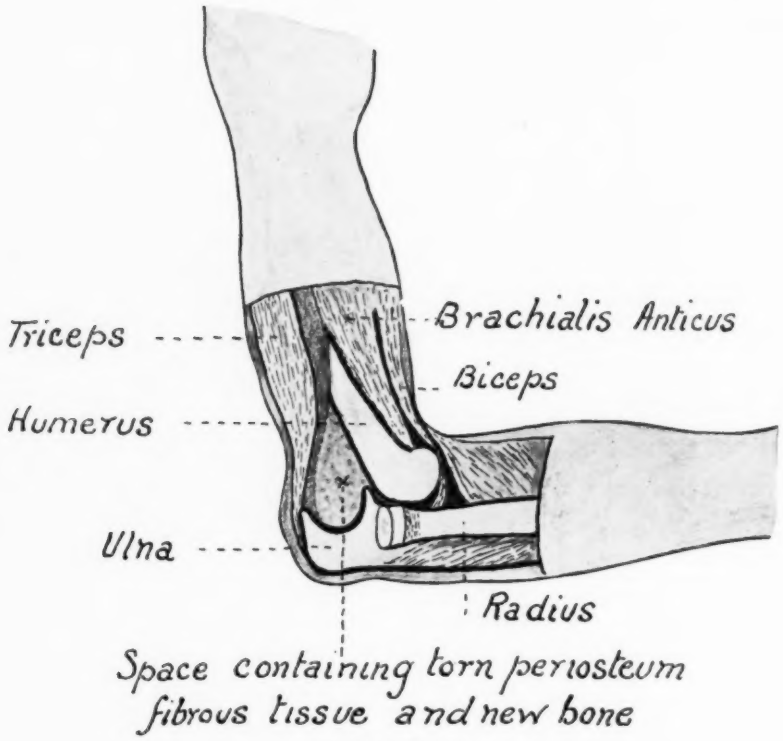


FIG. 8

Diagram of posterior dislocation of the elbow to show the space where new bone forms and acts as an obstacle to reduction.

the joint should again be gently carried through its full range of motion and those structures producing any obstruction be carefully divided. Patience and gentleness at this stage of the operation are imperative and if practiced will result in success.

Following reduction, either a portion of the tendo achillis is removed or a strong strip of fascia lata is obtained from the patient's thigh. This material is then employed as a connecting link between the divided triceps tendon ends (Fig. 4) and remains *in situ* as a living graft. To it the triceps muscle expansions are approximated (Fig. 5), after which the two strands of tendon or fascia are sewed together in the mid-line (Fig. 6). During the suture of the transplanted tendon, with silk, the forearm is held in the right-angle position and remains so during the closure of the wound which is performed without tension in the usual way (Fig. 7). A light molded plaster slab is used as a splint. This is applied over the anterior aspect of the arm, the elbow being held in a position of seventy to ninety degrees of flexion.

POSTOPERATIVE CARE

Stitches are removed on the tenth day and the plaster shell discarded at the end of two weeks. Gentle motions are then started and a Jones collar-

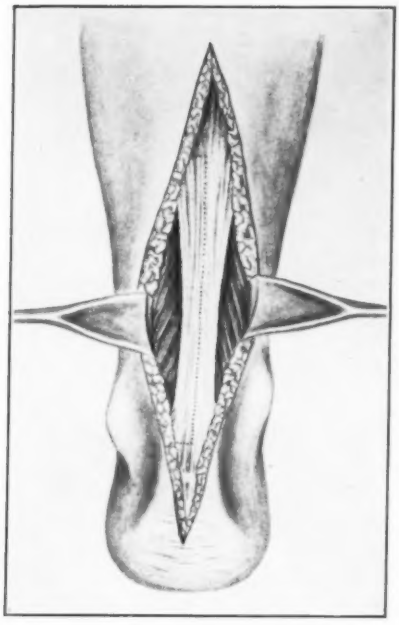


FIG. 9

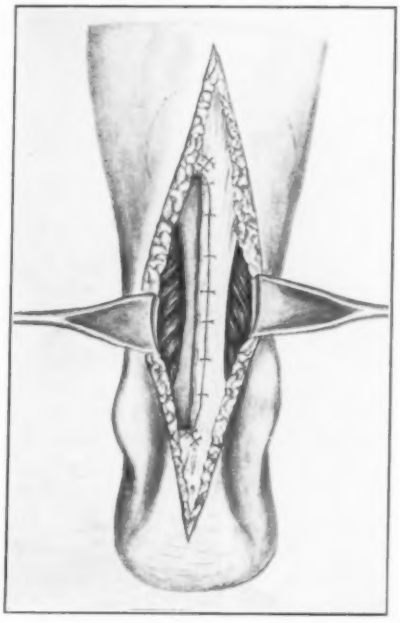


FIG. 10

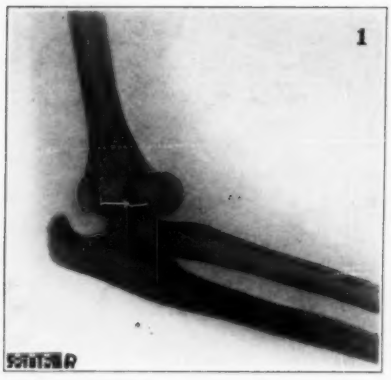
Diagram illustrating the use of a portion of the tendo achillis if desired as a graft for the triceps tendon. In the series of cases here presented, fascia lata was found to be equally successful as a transplant.

and-cuff sling applied. This sling holds the forearm in a position of acute flexion, where it remains constantly for another two weeks, except at times of exercises which are given twice daily. These exercises consist in very slowly and gently extending the arm and then directing it through as wide a range of motion as possible, but always stopping at the point of acute pain and never forcing the joint.

At the end of this two weeks' period of gentle exercises, which is one month after the operation, the Jones collar-and-cuff sling is used only at night to retain the position of acute flexion, while during the day the arm is given complete freedom. Physiotherapy, consisting of baking, massage, and active and passive motions, is now employed daily and continued for as long a period as required. Should the joint stiffen or "shut-down", a short period of rest is often of great advantage in regaining the lost function; additional x-rays should always be taken to ascertain the possible presence of new bone formation which, if disclosed, is a contra-indication to continued physiotherapy.

CASE REPORTS

CASE 1. Shang Teh Sheng, a Chinese soldier, aged forty, fell from his horse three weeks before admission to the hospital, sustaining a severe injury to his right elbow, which he had held in a position of extension and supination when he attempted to break the force of his fall. Following the accident he noted that this elbow was stiff and very



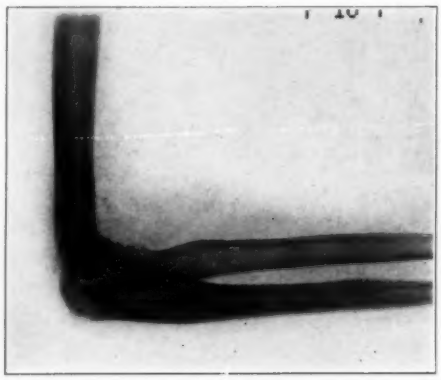


FIG. 11 FIG. 12

Case 1. Posterior dislocation of right elbow of three weeks' duration.
Fig. 11. X-ray before operation. Fig. 12. X-ray after operation.

painful and at the same time swelling of the entire arm appeared, which subsided after a period of ten days.

Ten days prior to admission to the hospital he had had his elbow joint manipulated repeatedly by some Army surgeons in an effort to flex the forearm, but all attempts were unsuccessful and he was still unable to use the right arm. Family history and past history were irrelevant.

Physical Examination: Outside of the local surgical condition, there was nothing unusual in the general physical examination. The patient's right arm was held in a position of 175 degrees at the elbow joint with a limited range of flexion and extension of ten degrees. Pronation and supination were also markedly limited. In the cubital fossa was a mass which on palpation was considered to be the lower end of the humerus. The olecranon process of the ulna was higher than normal. There was about one-half inch of shortening of the right arm. Examination for possible nerve injury revealed anaesthesia of the ulnar side of the right hand with inability to abduct and adduct the fingers, and definite weakness of the ring and little fingers.

Diagnosis: A clinical diagnosis of "posterior dislocation of the right elbow with ulnar nerve injury" was made. X-ray report stated "complete backward dislocation of the

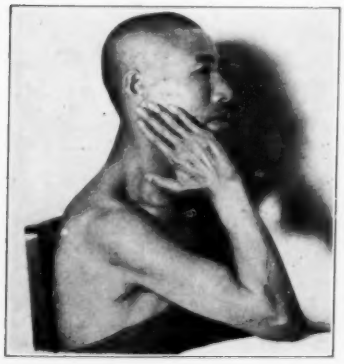


FIG. 13-A

Case 1. Condition one year after operation, showing voluntary flexion.

FIG. 13-B

Case 1. Condition one year after operation, showing voluntary extension.

FIG. 14

Case 2. Posterior dislocation of left elbow of eighty days' duration, showing condition before operation.

elbow joint without gross fracture, but with slight new bone production, presumably a result of periosteal stripping from the lateral epicondyle".

Preoperative Notes: An attempt at closed reduction of the dislocation was made under ether anaesthesia, care being taken not to fracture the olecranon tip. The result was a failure. Following manipulation, the arm was protected and placed at rest to allow for the subsidence of swelling. Two weeks later operation was performed.

Operation: Open reduction of old irreducible dislocation of the right elbow. Autogenous tendon graft from tendo achillis to triceps tendon.

Postoperative Course: First dressing on the tenth day, stitches removed. Wound healed *per primum*. Cast discarded. Arm held in acute flexion by Jones sling. Gentle motion started. Postoperative x-ray report states that the bones of the joint are now in normal position.

Discharge Note: Patient left the hospital one month after operation and continued physiotherapy for another month, when he was forced to return to his regiment. At this time, examination showed flexion to be perfect, rotation perfect, and extension 165 degrees. The ulnar nerve weakness showed evidence of improvement.

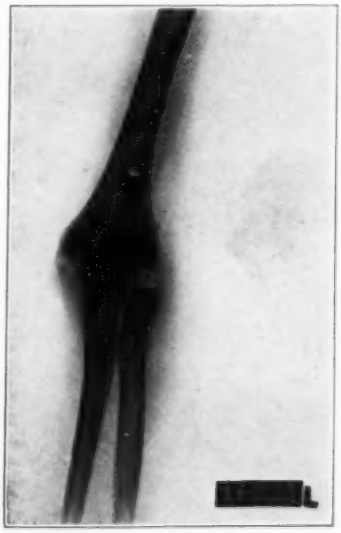


FIG. 15-A

Case 2. Anteroposterior view before operation.

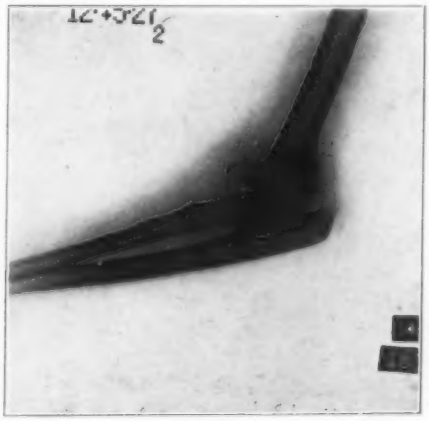


FIG. 15-B

Case 2. Lateral view before operation.

Follow-up: One year after operation the patient was again examined. His right elbow showed almost perfect function with the exception of ten degrees' limitation of extension. The transplanted tendon was functioning very well and voluntary extension, although not quite so strong as on the normal side, was satisfactory and increasing in degree.

Case 2. Ma Shih Tsao, a Chinese farmer boy, aged fourteen, fell from a donkey's back eighty days before admission and injured his left elbow. Immediately following the accident there was extreme pain and swelling in the joint and he was unable to flex it. A local doctor was consulted who massaged the joint and applied a wooden splint with the arm in its extended position. One month later this splint was removed, but the patient was still unable to bend his arm. Family history and past history irrelevant.

Fig. 16-A

Case 2. Anteroposterior view after operation.

Fig. 16-B

Case 2. Lateral view after operation.

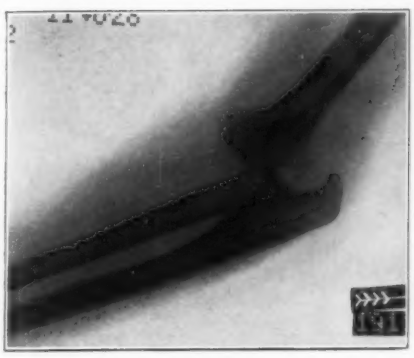
Physical Examination: There was nothing remarkable in the general physical examination. Locally the left arm was held in an extended position of 150 degrees, and could not be moved more than a few degrees at the elbow. The elbow joint itself appeared abnormal in contour and palpation revealed the olecranon displaced posteriorly. Pro-

Fig. 17-A

Case 2. Condition four months after operation, showing voluntary flexion.

Fig. 17-B

Case 2. Condition four months after operation, showing voluntary extension.



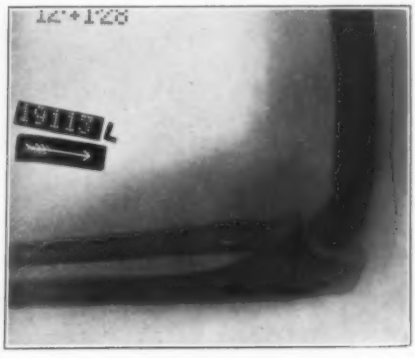


FIG. 18 FIG. 19

Case 3. Posterior dislocation of left elbow of four weeks' duration.
Fig. 18. X-ray before operation. Fig. 19. X-ray after operation.

nation and supination were limited. All of the characteristic signs of an old posterior dislocation of the elbow joint were in evidence. No peripheral nerve injury was detected.

Diagnosis: A clinical diagnosis of "old irreducible posterior dislocation of the left elbow joint, with question of associated fracture", was made. X-ray examination showed "fracture dislocation of the left elbow with considerable new bone attached to the posterior surface of the distal end of the humerus".

Operation: Open reduction of old posterior dislocation of left elbow joint, complicated by supracondylar fracture. Autogenous fascia transplant from fascia lata to triceps tendon.

Postoperative Notes: Convalescence uneventful, except for partial anaesthesia over ulnar distribution of the left hand and ulnar weakness. All stitches out on the fourteenth day postoperative. Wounds healed *per primum*, and physiotherapy was begun. Postoperative x-ray examination showed the bones of the joint to be in normal position.

Follow-up: Four months after operation the voluntary movements of the left elbow were as shown in the accompanying photographs and the ulnar nerve condition was steadily improving. Two years after operation the patient's father reported that there was no pain in the elbow, rotation was unrestricted, the ulnar nerve involvement had cleared up entirely, and flexion of the joint was unlimited but extension was restricted to 160 degrees by actual measurement.

CASE 3. Wang Hai Ning, a Chinese merchant, aged nineteen, fell from his horse twenty-seven days before admission, with his left arm in an extended position. He lost consciousness for a few minutes and upon awakening felt great pain in his left elbow which appeared to be locked in an extended position. A Chinese doctor applied some splints to his arm without altering its position and painted some medicine on the skin to relieve the intense swelling. Because of no apparent relief under this treatment, he came to the hospital to be cured. Family history and past history irrelevant.

Physical Examination: The general physical examination showed nothing remarkable. Locally the left arm, which appeared to be swollen, was held in an extended position and could not be flexed or rotated beyond a few degrees at the elbow. All movements caused pain. Examination of the elbow joint proper showed a disturbance of the normal bony landmarks, the olecranon tip resting two and five-tenths centimeters above the level of the condyles, and the distal end of the humerus projecting forward into the cubital fossa. There were no signs of peripheral nerve injury and no definite evidence of fracture.

Diagnosis: The clinical diagnosis was "old posterior dislocation of the left elbow joint". X-ray diagnosis was "complete posterior dislocation of the left radius and ulna with no evidence of gross fracture".

FIG. 20-A

Case 3. Condition six months after operation, showing voluntary flexion.

FIG. 20-B

Case 3. Condition six months after operation, showing voluntary extension.

Operation: Open reduction of old posterior dislocation of the left elbow joint. Autogenous tendon graft from tendo achillis to triceps tendon.

Postoperative Notes: Convalescence uneventful. Stitches removed on the tenth day. Both leg and arm wounds healed *per primum*. Plaster cast discarded and forearm held acutely flexed by Jones collar-and-cuff suspension. Gentle motions of the elbow started. Postoperative x-rays showed perfect reduction of the dislocation.

Follow-up: Six months after operation, the degrees of voluntary motion in the left elbow ranged between fifty and 130 as shown in the accompanying illustrations.

CASE 4. Wu Ching Po, a Chinese laundry woman of thirty-five, fell on her right elbow three months previously, while walking with a pail of washed clothing in her arms. As a result of the accident she noted that her elbow was locked in an extended position and was extremely sensitive to the least motion. Pain and swelling gradually subsided, however, while she kept her arm supported by a sling for a period of two months. Upon removal of the sling, the forearm gradually straightened a little more, but she was not able to flex it. Family history and past history were irrelevant.

FIG. 21-A

FIG. 21-B

Case 4. Posterior dislocation of right elbow of three months' duration. X-rays taken on admission to hospital.

FIG. 22

Case 4. X-ray showing condition after attempt at closed reduction of dislocated elbow. The olecranon has been fractured.

FIG. 23

Case 4. X-ray showing condition after operation.

Physical Examination: Aside from the local surgical condition there was nothing unusual in the patient's general physical examination. Her injured arm was held in an extended position at the elbow, and could be flexed only a few degrees. Lateral mobility was increased, however. Palpation of the structures forming the joint showed the olecranon displaced upward and the distal end of the humerus resting anteriorly in the cubital fossa. There was no definite evidence of fracture, and no signs of peripheral nerve injury.

Diagnosis: The clinical diagnosis was "old posterior dislocation of the right elbow, associated with recent fracture of the olecranon". X-ray diagnosis corroborated the clinical diagnosis.

Preoperative Note: Under ether anaesthesia, an attempt was made to reduce the dislocation by the closed method. It not only failed but resulted in a fracture of the olecranon, making an operative procedure imperative.

Operation: Open reduction of old dislocation of the right elbow, wiring of olecranon. Autogenous tendon graft from the tendo achillis to triceps tendon.

Postoperative Course: Convalescence was uneventful. Stitches were removed on the fourteenth day. Both arm and leg wounds healed

FIG. 24-A

Case 4. Condition three months after operation, showing voluntary flexion.

FIG. 24-B

Case 4. Condition three months after operation, showing voluntary extension.

FIG. 25

Case 5. Posterior dislocation of left elbow of three months' duration, with arm locked in position of extension.

nicely. Cast was discarded and gentle motions of the elbow joint were started two weeks after operation. Forearm was held in acute flexion by Jones collar-and-cuff suspension. Postoperative x-ray examination showed a perfect reduction of the dislocation and the fractured tip of the olecranon held in place by wire. At the time of leaving the hospital she could flex the elbow to fifty degrees and extend it to 135 degrees.

Follow-up: Three months after operation the range of voluntary elbow motion as shown in the accompanying photographs was seventy-five degrees. Passive motion showed flexion to be thirty degrees and extension 160 degrees. Pronation and supination were unrestricted.

CASE 5. Wang Tzu Liang, a Chinese merchant of twenty-one years, fell from his bicycle about three months previously and dislocated his left elbow, the left arm being locked in a position of extension. Soon after the injury he was treated by a Chinese native doctor who manipulated his arm, but failed to obtain a reduction of the dislocation. During the past three months, the pain and swelling had gradually disappeared but the patient was not able to flex his arm.

FIG. 26

Case 5. X-ray before operation.

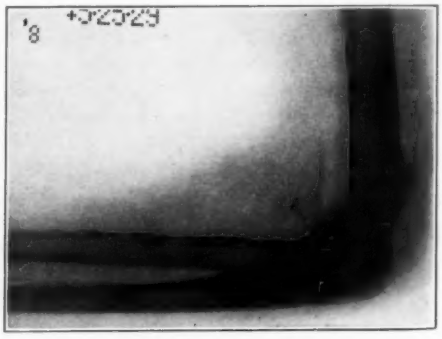


FIG. 27

Case 5. X-ray after operation.

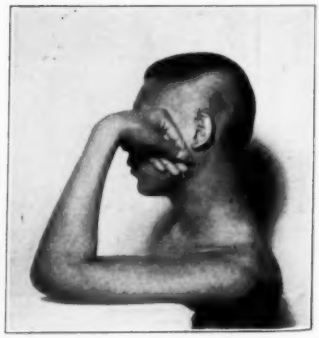


FIG. 28-A

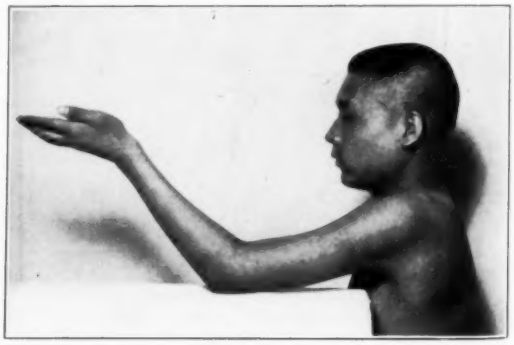


FIG. 28-B

Case 5. Condition two months after operation.

Physical Examination: There was nothing unusual in the patient's general physical examination aside from the condition of his left elbow joint, which was held in an extended position and permitted only a few degrees of motion. The normal relationship of the bones at the elbow was disturbed, the olecranon being felt above the interepicondylar line, and the cubital space contained a bulging mass that was considered to be the lower end of the humerus. Actual measurements showed the left arm to be two centimeters shorter than the right. There was no evidence of peripheral nerve injury.

FIG. 29

Case 6. Posterior dislocation of elbow of two months' duration, showing fixed extension deformity.

Diagnosis: The clinical diagnosis was "old posterior dislocation of the left elbow joint". X-ray diagnosis: "Complete dislocation of the radius and ulna posteriorly, the coronoid process impinging on the posterior surface of the medial epicondyle of the humerus. There is a fairly large amount of new bone formation on the lower anterior and posterior surfaces of the humerus."

Operation: Open reduction of old posterior dislocation of the left elbow joint. Autogenous tendon graft from tendo achillis to triceps tendon.

Postoperative Notes: Convalescence was uneventful. Wound healed by primary union. Sutures and arm cast were removed on the fourteenth day. Forearm was held in acute position by means of a Jones collar-and-cuff sling. Gentle exercises were started. Postoperative x-ray examination showed "good position of the bones of the left elbow joint after reduction of the dislocation".

Discharge Note: The patient was transferred to the convalescent home three weeks after operation, at which time the range of motion in his left elbow joint was between forty-five and ninety degrees.

Follow-up: Two months after operation, examination showed active movements of the elbow to be fifty-four degrees' flexion and 132 degrees' extension. Passive movements were forty-nine degrees' flexion and 136 degrees extension. Another x-ray taken at this time to ascertain the cause

FIG. 30-A

Case 6. Anteroposterior view before operation.

FIG. 30-B

Case 6. Lateral view before operation.

of limitation of motion showed the formation of new bone anteriorly, which interfered with flexion. No apparent cause was found for the limited extension, however.

Case 6. Hu Ho Pao, a Chinese male of twenty years, fell out of a rickshaw two months previously and injured his right elbow. Since then, there had been pain and swelling, also deformity of the joint and he had not been able to flex his forearm, which remained locked after the accident in a position of extension. He had had massage and manipulation of the joint by native practitioners without improvement. Family and past history irrelevant.

Fig. 31-A

Case 6. Anteroposterior view after operation.

Physical Examination: The right forearm was held at an angle of 160 degrees' extension, only a few degrees of flexion and extension being possible from this position. Lateral mobility was increased beyond normal. Rotation was slightly limited. The olecranon was prominent posteriorly and could be palpated above the intercondylar line. There was an ab-

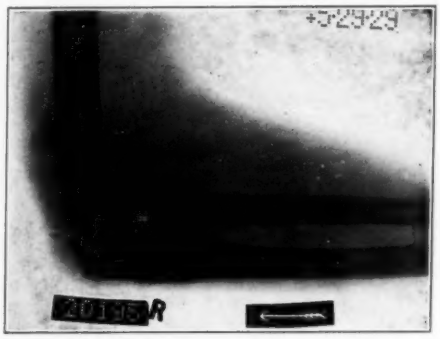


Fig. 31-B

Case 6. Lateral view after operation.

Fig. 32-A

Case 6. Condition two months after operation, showing voluntary flexion.

Fig. 32-B

Case 6. Condition two months after operation, showing voluntary extension.

normal fullness of the antecubital space and an apparent shortening of the forearm as compared with the opposite side. There was no evidence of nerve injury.

Diagnosis: A clinical diagnosis of "posterior dislocation of the right elbow joint" was made, and the x-ray report confirmed this, adding that there was evidence of injury to the periosteum of the medial epicondyle of the humerus.

Operation: Open reduction of old posterior dislocation of the right elbow. Autogenous fascia transplant from fascia lata to triceps tendon. Plaster shell from the shoulder to fingers with elbow in right-angle position.

Postoperative Notes: Uneventful convalescence. Operative wounds healed *per primum*. Cast was discarded at the end of two weeks and exercises started. Jones collar and cuff employed. Postoperative x-rays showed the relationship of the bones of the elbow to be excellent with their articular surfaces in normal position.

Discharge Note: Patient was transferred to the convalescent home three weeks after operation, at which time, his right elbow motions showed fifty degrees' flexion and 130 degrees' extension.

Follow-up: The patient was last seen by the writer three months after his operation, when examination showed flexion of the right elbow joint to be normal and extension to equal 175 degrees.

DISCUSSION

In the actual reduction of old posterior dislocations of the elbow, it is perfectly evident that two main obstacles have to be overcome: (1) the contracted triceps tendon, and (2) the mass of fibrous tissue and callus that collects in the triangular space bordered by the posterior surface of the lower end of the humerus, the triceps tendon, and the dislocated olecranon incisura (Fig. 8). The contracted triceps tendon must be either stretched, separated from its insertion, or lengthened, and the mass of tissue, resulting from blood clot, torn capsule, and separated periosteum, must be completely removed from behind the humerus before a perfect reduction can be secured.

Forceful stretching of the triceps in cases of long standing is so productive of trauma both to muscles and to the trochlea of the humerus as to be unjustifiable. Separation of the triceps insertion by subperiosteal dissection or by osteotomizing the olecranon (the transolecranon approach) has long been the method of choice for many European and American surgeons, but it has the distinct drawback of not permitting easy approximation of the divided structures for suture after reduction is accomplished. In fact, approximation of the tendon to its insertion is so frequently impossible after reduction, that the lower end of the humerus is often sacrificed in order to accomplish the purpose. Even should it be possible—as in the rare case—to suture the olecranon back into position or the tendon back to the periosteum, the forearm invariably must be kept in a position of extension in order to relieve tension on the sutures; this position prevents early function, favors recurrence of the dislocation, and is decidedly detrimental to a favorable result.

The lengthening of the triceps tendon is a more recent method of overcoming the muscle contraction, and has been accomplished in several ways, one of which has been a simple "step-cut" lengthening procedure;

and another a dissection of the tendon from its muscle attachments and sliding it distally to a new position between the divided muscle edges after the method of Bennett[1]. A somewhat similar procedure has been advocated by Speed[2].

The objection to the "step-cut" operation is largely anatomical, in that the tendinous portion of the triceps muscle is not over one and one-half inches in length, which does not allow sufficient lengthening of it with adequate suture to serve the best requirements of future function. For early cases, or those in which the triceps muscle length has been maintained, this method can undoubtedly be used with success; but as a safe and sure procedure for all cases, it is, in the writer's judgment, definitely inadequate.

The dissection of the tendon from its muscle attachments, and sliding it distally to an insertion at a lower level, also has disadvantages. Chief of these is the anatomical relationship of the triceps tendon to its muscle. The tendon divides into two separate layers as it extends upward into the muscle tissue, which means that to dissect it away from all of its attachments requires a cutting of considerable muscle tissue and an undue amount of trauma. Because of this anatomical relationship, the writer feels that the triceps muscle and tendon are not suitable for this kind of procedure. In his hands it always seemed a rather messy, bloody, and unavoidably traumatic operation, and the suture repair not very satisfactory. In addition, he and his colleagues have found difficulty in certain cases in securing sufficient lengthening of the triceps muscle even by this method.

The use of tendon or fascia lata as a means of lengthening the triceps has the advantage of permitting any required length without sacrificing unduly the strength and function of the muscle. This fact was appreciated after the published work of Gallie[3], who in 1922 showed that transplanted fascia and tendon would not only remain alive but would unite with other body structures.

Lengthening of the triceps tendon by this method has obviated, in the writer's experience with elbow dislocations unassociated with fracture, the necessity for partial or complete resection of the joint. Resection should be reserved only for dislocations with complicating joint fractures or those associated with infection. It no longer has a place in old uncomplicated dislocations of the elbow and its connections with this condition in the future should be only historical. With our newer surgical methods, we need no longer shorten the humerus at its articulation in order to obtain reduction but rather secure a far happier result by lengthening the triceps tendon.

SUMMARY

In posterior dislocation of the elbow of over three weeks' duration, closed methods of reduction are contra-indicated.

In old posterior dislocations of the elbow, uncomplicated by fracture, operative reduction is demanded; and the operative procedure of choice is the one which will allow careful preservation of the articulating joint surfaces and a reduction of the dislocation with a minimum of trauma.

A simple operative method which has been successful in accomplishing these two purposes is presented by the writer with a report of six cases.

Resection should have no place in the treatment of old uncomplicated posterior dislocations of the elbow, but be reserved for cases associated with major fractures or infection.

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EARLY SIGN OF TUBERCULOUS SPONDYLITIS IN THE PREGIBBUS STAGE*†

From the Department of Bone Diseases of the Odessa State Institute of Tuberculosis

BY DR. S. KOFMAN, ODESSA, U. S. S. R.

TRANSLATED FROM THE GERMAN BY EMANUEL KAPLAN, M. D., NEW YORK, N. Y.

The early diagnosis of spondylitis is of primary importance. The roentgenogram in the early stages is unreliable. The classical symptoms are: pain, loss of motion, and deformity. The first is not always reliable; the second requires experience and the ability of observation; the third is relatively a late symptom not present in twenty per cent. of the cases. Many years of observation have taught us that there should be some evidence of the disease in its initial pregibbus stage.

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†This clinical sign is also mentioned in a paper presented by Dr. Kofman at the meeting of the Orthopaedic Association in Leningrad, April 6, 1931, which paper is published in full in *Archiv für Orthopädische und Unfall-Chirurgie*, XXX, 308, 1931.

In examining a healthy individual, with his back facing the light and his arms hanging at the sides, there is seen an irregular groove extending along the spine from the neck to the sacrum. This groove varies in depth according to the muscular development of the individual, and is enclosed between the two muscular bands of unequal thickness along their course. If the spine is affected, it is observed that these muscular bands diverge more or less, forming a rhomboid or an oval-shaped depression—"*Delle*". Palpation of the muscles encircling the depression (sacrolumbalis) shows them to be soft, somewhat doughy, and that they do not contract. This is more evident with the patient in a prone position.

Our observation for the last five years has demonstrated this depression, *Delle*, to be the location of the future gibbus. Rarely, two or three depressions are present, which is an indication of double or triple localization. An atrophy of the entire back, an absence of the spinal groove, with soft muscles suggest the presence of an affection of the entire spine. Sometimes two or three years elapse before the gibbus deformity becomes evident, and, in rare instances, the gibbus does not appear at all (spondylitis superficialis anterior of Hoffa), but other manifestations—abscesses, lameness, etc.—occur, which indicate the presence of the probable lesion. We have observed cases in which the diagnosis of spondylitis was established two or three years in advance, although the roentgenogram (with the exception of a slight narrowing of the intervertebral disc) and the other manifestations did not indicate the presence of a lesion.

The appearance of the oval depression, *Delle*, with the flattening of a definite part of the spinal groove, is not in itself pathognomonic of a tuberculous lesion of the spine, but indicates that this part of the spinal column does not participate in the motion of the entire spine; it may be observed in spondylitis and other processes involving the mobility of the spine. The specific sign is the softening of the long muscles of the back. The muscular attachments which arise from the affected vertebrae lose their tonus in the same manner that the quadriceps femoris loses its tonus in tuberculous gonitis.

It is interesting to observe that, in case of a favorable turn in the process, the muscles regain their contractility and firmness.

FUSION OF THE ELBOW JOINT FOR TUBERCULOSIS

A New Technique and a Report of Three Cases

BY HALFORD HALLOCK, M.D., NEW YORK, N. Y.

Fellow of the New York Orthopaedic Dispensary and Hospital

A description of a new technique for fusion of the elbow joint and the reports of three cases treated by fusion are given. The first two cases were fused in the manner to be described. The third one had to be fused in a different way because of gross involvement of the olecranon bone by the disease, for the subsidence and repair of which we had unwisely waited. The principle of the procedure lies in the use of a mass of cancellous bone, the olecranon process, with its soft-tissue attachments intact, to bridge the joint from humerus to ulna. It is modeled from the method of hip fusion described by Dr. Russell A. Hibbs in *The Journal of Bone and Joint Surgery* (VIII, 522, July 1926). Microscopic sections from triceps tendons in cadavera studied in our laboratory have shown the presence of blood vessels running from the tendon and its surrounding connective tissue into the bone of the olecranon, and it is believed that such a mass of bone, with these vascular connections intact, provides a favorable situation for bone growth and fusion.

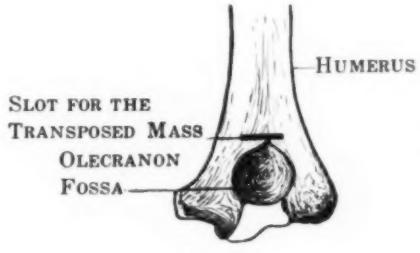

FIG. 1

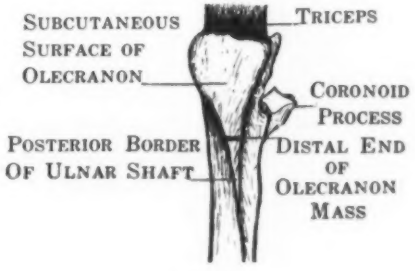

FIG. 2

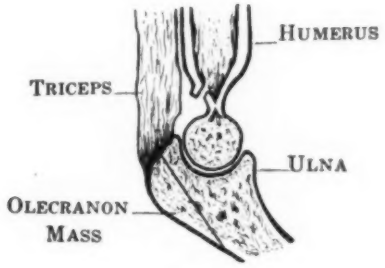

FIG. 3

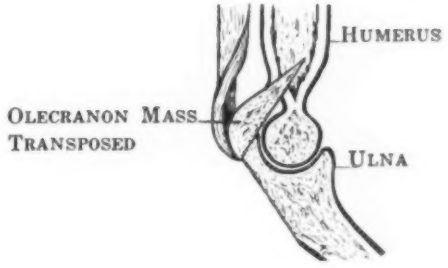

FIG. 4

OPERATIVE TECHNIQUE

With the patient in the prone position and the elbow flexed over a support on the arm board, a dorsal mid-line incision is made and the posterior region of the elbow joint exposed. The periosteum of the ulna is divided along both sides of the subcutaneous olecranon surface and down the posterior border of the shaft, and the sides of the olecranon process and upper ulnar shaft are exposed subperiosteally. This exposure is accomplished easily and pushes the ulnar nerve away from the immediate operative area. The posterior half of the olecranon with its periosteum and triceps tendon, together with some of the ulnar cortex, is raised with a chisel and reflected proximally. This exposes the joint, and tissue is removed for examination. The superior surface of the olecranon stump and the posterior aspect of the humerus are bared and a slot cut obliquely upwards into the humerus at the upper border of the olecranon fossa. The mass of bone with its muscle attachment is mobilized, rotated 180 degrees, and driven into the humerus so that the original distal end penetrates deeply into that bone and the proximal portion comes to lie against the bared stump of the olecranon with the elbow flexed at 120 to 130 degrees. (Full extension is considered as 180 degrees.) If desired, a few bone chips, easily obtained from adjacent healthy areas of humerus or ulna, may be placed along the line of contact with the ulna, and the mass is then anchored to the ulna with chromic periosteal sutures. The wound is closed in layers and a plaster cast applied from hand to axilla.

CASE REPORTS

Case 1. A.U. 5668. An Italian woman of fifty admitted to the wards of the New York Orthopaedic Dispensary and Hospital, December 19, 1928, complained of trouble with the left elbow since 1914. She had been followed in the dispensary from 1914 and

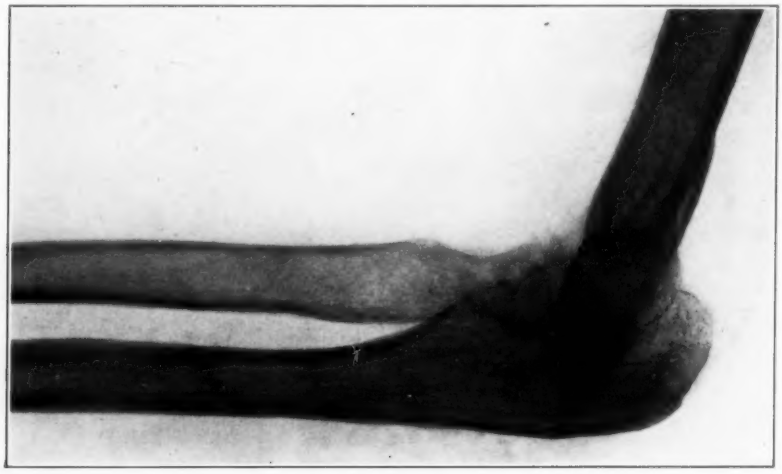

Fig. 5
Case 1, No. 5668. Preoperative x-ray.

FIG. 6

Case 1, No. 5668. Postoperative x-ray.

had been treated with braces and the aspiration of an abscess early in the course of the disease. The clinical diagnosis was tuberculosis. Periods of remission occurred but the symptoms always returned.

Examination: The left elbow was swollen, thickened, and tender. It was held at ninety-five degrees' flexion and permitted only ten degrees of motion, which was accompanied by acute pain and spasm. Pronation and supination were limited to five degrees. An old sinus scar was present. The x-ray showed marked loss of substance with some reparative changes and suspicious evidence of effusion anteriorly.

Operation: Elbow fusion, left, December 27, 1928. Granulation tissue, appearing tuberculous in nature, was found within the joint. No pus was encountered. All bone used in the procedure was of good appearance and consistency. The elbow joint was fused in the manner previously described. A few bone chips were placed along the line of contact of mass and ulna.

Pathological report: Chronic inflammation with tubercle formation.

FIG. 7

Case 1, No. 5668. Six months after operation. Fusion through the transposed mass.

FIG. 8

Case 1, No. 5668. Two years after operation. Complete fusion of the joint.

Postoperative x-ray: Olecranon fragment in good contact with humerus and ulna and well implanted in the former.

Course: There were no operative complications and the wound healed well. On April 30, 1929, four months after operation, the plaster was changed. There was slight, springy motion but no pain or spasm. The x-ray indicated fusion. Plaster was retained until May 14, 1929, four and one-half months after operation. The elbow was clinically solid.

Follow-up examination: The patient has since been without pain or evidence of disease. The last examination, April 14, 1931, revealed a fused elbow at 120 to 130 degrees. There was no tenderness, swelling, spasm, or sinus. The forearm was held in a mid-position and allowed five degrees of pronation and forty-five degrees of supination without pain or spasm. The x-ray showed complete fusion of the joint.

CASE 2. R.D. 123204. An American male of twenty-two admitted to the hospital October 16, 1929, complained of pain and swelling in the left elbow of four years'

FIG. 9

Case 2, No. 123204. Preoperative x-ray.

FIG. 10

Case 2, No. 123204. Postoperative x-ray.

duration. In 1928 the joint was operated upon in another hospital and a resection of the radial head performed.

Examination: The left elbow was hot and swollen and was held at 100 to 110 degrees. Only ten to twenty degrees of motion was possible and was accompanied by acute pain and spasm. The x-ray showed loss of substance, erosion, smoky decalcification, and a dense, well defined effusion. There was slight productive reaction and the head of the radius had been resected.

Operation: Elbow fusion, left, October 21, 1929. Typical diseased granulation tissue was found in the region of the joint. The bone appeared to be of good consistency and

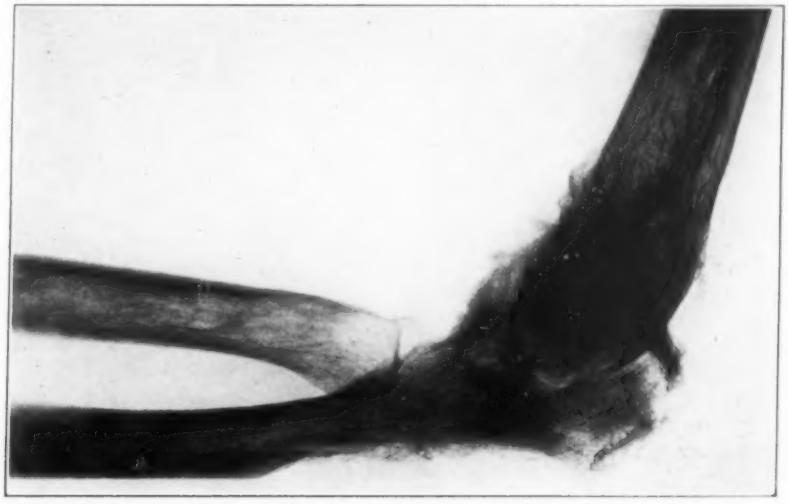

FIG. 11

Case 2, No. 123204. Prerefusion x-ray. Failure of fusion at site of green-stick fracture.

FIG 12

Case 2, No. 123204. Eleven months after refusion. Complete fusion of the joint.

no disease was encountered in it. Immediate frozen section revealed tuberculosis. The mass projected posteriorly and was green-sticked down over the bared posterior surface of the ulna and held with periosteal sutures. Bone chips were placed at the line of contact of mass and ulna.

Postoperative x-ray: Bones and fragments were well apposed at about 110 degrees. Distal end of mass green-sticked over posterior surface of ulna.

Course: There was a moderately severe postoperative reaction. The transposed mass united quickly and firmly at both ends, but bone absorption and a pseudarthrosis developed at the site of the green-stick fracture. On April 14, 1930, six months after operation, the man was admitted to the hospital for refusion.

Operation: Refusion of elbow, April 18, 1930. The transposed mass of bone was firmly united at both ends to humerus and ulna, but at the former site of incomplete fracture there was no union and the interval, as well as the posterior, part of the joint was filled with granulation tissue and some pus. The proximal portion of the transposed mass was removed, the posterior portion of the joint curetted and the area filled with bone chips removed from the left ilium. A new mass of bone, with the triceps attachment preserved, was raised from the olecranon, rotated 180 degrees, and driven obliquely into the posterior surface of the lateral condyle, the original proximal portion making good contact with the olecranon stump.

Pathological report: Tuberculosis.

Postoperative x-ray: Transplant and numerous small chips in excellent contact from ulna to humerus.

Course: There was again a moderately severe reaction. The wound healed well except for the development of two small sinuses. Four months after operation the elbow clinically and by x-ray was fused, but plaster was retained for two months more for safety while the patient was at a summer camp. Six months after operation the elbow was solid and the sinuses healed.

Follow-up examination: At the last examination, May 5, 1931, one year after operation, the elbow was fused at 130 degrees. There was no swelling, spasm, or sinus. The x-ray showed complete fusion of the joint. It is to be noted that in the elbow, as well as in the hip, fusion of the diseased bone ends follows upon the fusion of more healthy areas obtained by operation.

FIG. 13

Case 3, No. 106421. Preoperative x-ray.

The weakness in the technique in this case was the green-stick fracturing of the mass over the olecranon stump. The mass should have been either shorter in length or driven more deeply into the humeral shaft so that no projection would have occurred.

CASE 3. R.F. 106421. A two-year old Italian girl was admitted to the dispensary December 28, 1927. It was reported that for fifteen months she had been unable to straighten out the right elbow. The child appeared chronically ill. The elbow was held flexed, and swelling and spasm were present. The x-ray disclosed cavitation of the right ulna at the elbow, with effusion into the joint. The child was admitted to the hospital in March 1928 and the elbow was explored and found by microscopic section to be tuberculous. She was then sent to the country branch in the hope that under prolonged and controlled care the disease would subside and the bone repair, making the situation more

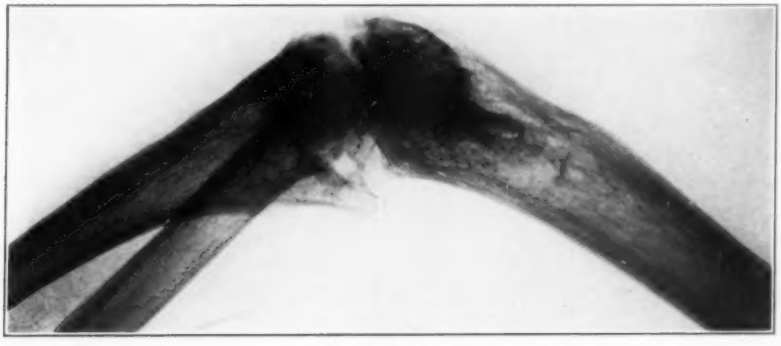

FIG. 14

Case 3, No. 106421. Five and one-half months after operation; one and one-half months before refusion. Pseudarthrosis opposite the joint line.

FIG. 15

Case 3, No. 106421. Postrefusion x-ray.

favorable for fusion. The disease seemed to subside but again became active, with abscess formation. Aspiration and then incision and drainage were done on September 19 and 25. After this the condition of the joint improved, but the disease never became inactive, and in April 1930 it was decided to proceed with fusion.

Operation: Elbow fusion, right, April 29, 1930. Gross disease was found in the elbow joint with such extensive involvement of the olecranon that it could not be used in the usual manner as a transposed mass with muscle attachment. Diseased granulation tissue was present in large amount and some pus was also found. As it was impossible to use the olecranon in the fusion procedure, the humerus and ulna were subperiosteally bared. The larger part of the diseased tissue and bone was removed and a shallow groove fashioned across the joint line, which was filled, from normal bone proximally to normal bone distally, with chips removed from healthy areas of humerus and ulna.

Pathological report: Tuberculosis.

Postoperative x-ray: Numerous small chips about ulna and humerus.

FIG. 16

Case 3, No. 106421. Six and one-half months after refusion. Complete fusion of the joint.

Course: The patient made an uneventful recovery but the elbow did not fuse. In November 1930, seven months after operation, it was decided to refuse the joint.

Operation: Refusion of right elbow joint, November 28, 1930. Two or three degrees of motion were present at the elbow joint through a line of pseudarthrosis. For the most part the intervening tissue was fibrous and the bone in fair condition, but deep in the joint granulation tissue and caseous material were found. The radio-ulnar joint, which was unintentionally opened, appeared normal and was closed at once. The area of pseudarthrosis was curetted and the bone cut back so as to make the line of non-union shallower. The whole area, from well up on the humerus to well down on the ulna and extending deep down into the joint, was packed with bone chips previously removed from the right ilium.

Pathological report: Tuberculosis.

Postoperative x-ray: Humerus and ulna in good apposition through the medium of abundant small chips.

Course: An uneventful recovery ensued and the elbow fused rapidly and well. On February 18, 1931, twelve weeks after operation, the joint was solid to gentle manipulation and there was no pain or spasm. The x-ray indicated fusion. Plaster was retained, however, until April 1, 1931, four months after operation, because of the strenuous activity of the child.

Follow-up examination: The last examination was made July 1, 1931, seven months after operation. The elbow felt solidly fused and was without pain, tenderness, or spasm. There were no sinuses and there had been no change in position. The forearm allowed forty-five degrees each of pronation and supination. The x-ray showed fusion and subsidence of disease.

The mistake in this case was to wait for disease subsidence and bone regeneration under prolonged conservative treatment. Valuable time was lost and increased hospitalization incurred.

SUMMARY

1. A new technique for fusion of the elbow joint is described. It consists of the use of a mass of cancellous bone, the olecranon, with its soft-tissue attachments intact, to bridge the joint from humerus to ulna, and is modeled from the method of hip fusion described by Dr. Russell A. Hibbs.

2. The reports are given of three cases of tuberculosis of the elbow joint treated by fusion.

SURGICAL TREATMENT OF LOW BACK DISABILITIES*

BY EDWIN W. RYERSON, M.D., CHICAGO, ILLINOIS

Professor of Orthopaedic Surgery, Northwestern University Medical School

When it has definitely been established that conservative treatment by mechanical, medicinal, and postural therapy has failed to relieve low-back disability, it becomes important to consider the possibility of relief by operation. In some patients, the pain and disability are not severe enough to warrant surgical interference. In some others, there exist contra-indications to anaesthesia or to the shock of operation. There remains, however, a large number of these sufferers who are materially handicapped by low-back disability and who are excellent surgical risks.

If this disability is known to be due to anatomical abnormality, such as spondylolisthesis or vertebral anomaly, or to weakness and instability of the joints, or is caused by an arthritis limited to the lumbosacral or sacro-iliac articulations, it is perfectly justifiable to attempt relief by arthrodesing or fusion operations designed to produce bony ankylosis of the affected joints.

In a fairly large series of such operations performed in the writer's clinic, the percentage of complete success has been so high that the procedure is confidently recommended as an almost certain means of relief.

The surgical risk is as small as in any other ordinary operation and the period of convalescence is scarcely more than the time involved in recovery from one of the acute attacks to which these people are subject.

We should, therefore, be ready to advise operation when the clinical picture is sufficiently clear, and should endeavor to convince the general practitioner that there is little danger and great possibility of cure in the surgical treatment of these conditions.

In many instances it is practicable to determine accurately the individual joint which is the seat of the disturbance. In most cases this is the lumbosacral joint. In a few it is the third or fourth lumbar joint. In a fair number it is one or both of the sacro-iliac joints. In some cases it has been impossible for the writer to be absolutely certain of the exact location of the disability, in spite of the most careful application of the usual special differential tests.

OPERATIVE TECHNIQUE

Because the operative fusion of the lumbosacral joint is most frequently utilized and is numerically the most important, it will here be considered first. The Hibbs technique undoubtedly produces excellent results where

*Read at the Annual Meeting of the American Orthopaedic Association, Memphis, Tennessee, April 16, 1931.

properly performed. It requires, however, more time and precision than is at all desirable. In certain cases where the bone-forming ability of the patient is at a low level, this operation may fail to produce a bony fusion. In most cases it is wise to add some large bone grafts taken preferably from the posterior crest of the ilium or from the tibia.

The Albee operation has the merit of greater rapidity. The writer, in 1911, performed the first lumbosacral fusion for spondylolisthesis that has been recorded, using an S-shaped, broad splint taken from the flat surface of the tibia. This operation was completely successful, and the patient twenty years later is perfectly well and has had no trouble with the back since the operation.

It is true, however, that in rare instances the Albee tibial splint has become absorbed in the course of months or years, through no fault in the technique, and after having united perfectly with the spinous processes of the vertebrae. This undesirable phenomenon has been observed in the practice of other surgeons, besides the four cases of the writer, and it creates a slight feeling of uncertainty in evaluating the procedure.

It would seem wise, therefore, to combine the merits of these two valuable and well standardized fusion operations and to perform a reasonably accurate Hibbs subperiosteal denudation of the laminae and spinous processes, with one or more large bone grafts removed from the iliac crest; these grafts being laid on the small Hibbs grafts or implanted in the split spinous processes.

This combined method has been used in a considerable number of cases operated upon in the writer's clinic, and with practically uniform success, and is recommended, without qualification, as being the safest and best technique, except where circumstances require the most extreme rapidity of operation. In the latter class of cases, the original Albee technique should be followed.

Sacro-iliac Fusion.—In cases where the fusion of only one sacro-iliac joint is required, the surgeon has the choice of several distinct and satisfactory methods. Smith-Petersen's subperiosteal approach to the outer surface of the ilium, with the removal of a rectangular block of ilium and its reimplantation into a socket cut into the sacrum, has been well described and perfected by its originator.

The writer has used it in many cases, and with excellent results. It causes practically no shock, is nearly bloodless, and can safely be recommended. When performed for the first time by the average operator, there is a feeling of uncertainty as to the exact location of the joint, and the cutting out of the block is somewhat trying on account of the great variation in the thickness of the ilium at different points in the operative field. In one of the more recent publications of the originator of this ingenious operation, the use of an electric motor-saw is advised. A motor-saw cannot safely or conveniently be used in this connection, and the thin-bladed osteotome is perfectly simple and satisfactory.

Bilateral Sacro-iliac Fusion.—Where both sacro-iliac joints require arthrodesis simultaneously, the writer has not used the Smith-Petersen technique, because of the fact that, in this series of cases, fusion of the lumbosacral joint was also performed. This combined operation, well termed by Chandler "trisacral fusion", can best be performed through a single transverse incision, convex either downward or upward. The fifth and usually also the fourth lumbar vertebrae are first attacked by the combined method above described, and the sacro-iliac joints are then subjected to either the Chandler or the Campbell operative technique. Chandler's method is mechanically correct, though more complicated and possibly more bloody than Campbell's. Either one is perfectly satisfactory when properly done. Not long ago Verrall proposed a transverse tibial graft placed across the sacrum and inlaid into holes bored into the iliac crests. The writer followed this technique in a single case, and the patient was relieved for nearly a year, when the original symptoms again appeared. At reoperation it was found that the tibial splint had united perfectly to the sacrum and to both ilia, but that a definite torsion or twisting of the splint had developed and could easily be demonstrated by levering the pelvis forward and backward. Both sacro-iliac joints were freely movable, and the graft could be seen to rotate on its long axis in either direction. Campbell's operation was then performed, and the patient states that he is now perfectly well. The writer feels that Verrall's method, as evidenced by this one case, is mechanically unsound, and should be abandoned.

SUMMARY

To summarize the points in this paper:

1. Ankylosis of lumbosacral or sacro-iliac joints will produce rapid relief in cases of pain and disability due to mechanical instability or to disease limited to these joints.

2. The best operative procedure for the lumbosacral region is a combination of the Hibbs technique with one or more large bone grafts removed preferably from the ilium; where great speed is imperative, the original Albee technique is recommended.

3. A single sacro-iliac joint can be satisfactorily fused by the Smith-Petersen technique, or by the Campbell or Chandler method. When both sacro-iliac joints require fusion, or where the trisacral fusion is required, Campbell's or Chandler's method should be combined with the lumbosacral operation above described.

THE CONSERVATIVE TREATMENT OF BACKACHE*

BY LLOYD T. BROWN, M.D., BOSTON, MASSACHUSETTS

The conservative treatment of backache from the orthopaedic standpoint opens up a large field.

Since the spine is made up of a great number of joints, the physiology of which is the same as that seen more easily in the wrist joints, for purposes of description the fundamental principles will be described as they are seen in the wrist.

It is fundamental that as long as the wrist is used within its normal range of motion, there is no strain. When motion is forced beyond one or the other extremes of the normal range, strain may occur. The strongest position, therefore, for the wrist is one approximately half-way between either of the extremes of flexion or extension,—a position, which, in the language of the mechanical engineer, has a factor of safety motion in either direction. If the wrist is held in a flexed or an extended position, there must be a loss of the factor of safety motion. In such a flexed or extended position, any motion toward the nearer extreme will cause a strain on the ligaments of the joint, unless the loss of this factor of safety motion can be

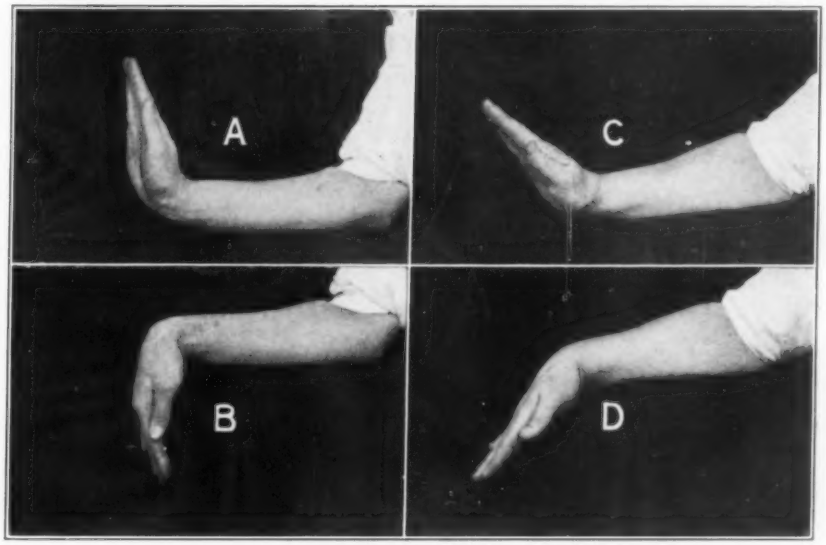

FIG. 1

Wrist 1 Wrist 2

Note the difference in total amount of motion in two normal wrist joints. Position *A*—full extension—could not be assumed by Wrist 2 without injury. Position *C* could be assumed by Wrist 1 with no injury, as there would still be a factor of safety motion.

*Read at the Annual Meeting of the American Orthopaedic Association, Memphis, Tennessee, April 16, 1931.

compensated for by muscular strength or by motion in some other part,—such as the hand, arm, shoulder, or body. Such compensation is always present and is the reason why the average individual does not strain or even break his wrist when he falls on it. It is very important to realize that the amount of the factor of safety motion varies with every individual wrist (Fig. 1). A very loose-jointed wrist (*A* and *B*) used in the optimum position will have a much greater factor of safety than a wrist with only half the amount of motion (*C* and *D*). Therefore, two wrists held in the same degree of flexion or extension may have very different factors of safety and the potential of trouble in one may be slight and in the other very great. One requires little or no compensatory effort to prevent injury and the other requires a great deal.

In the wrist, where there is no weight-bearing strain, the possibility of injury is much less than in a weight-bearing joint,—like the foot, or the spine. The pronated or valgus foot gives a very good example of what happens to joints when the faulty weight-bearing factor is present (Fig. 2). A foot with good weight-bearing lines (*A*) has the full factor of safety motion in all directions; in other words, there is little potential of trouble or injury while used in this position. A pronated or a valgus foot (*B*), on the other hand, since it has lost its factor of safety motion, and since the muscles, because of the bad mechanical position of the bones, must work at more or less of a disadvantage, has a great potential of trouble. Every time the weight comes on such a foot, the strain must be either on the ligaments or it must be compensated for by the knees or back. The pronation or valgus of such a foot, with its lessened factor of safety, by itself may cause no trouble. We all know, however, that such a valgus foot, when once it is injured, recovers much more slowly than a foot with good weight-bearing lines. We all know that after a fracture of the fibula, the strength comes back much more quickly if the foot has been held in a position of at least slight varus during the treatment. It is a common experience that, after a sprain of an ankle, for a long time there will be swelling or thickening around the ankle joints, particularly just in front of the external malleolus. This swelling is nature's reaction

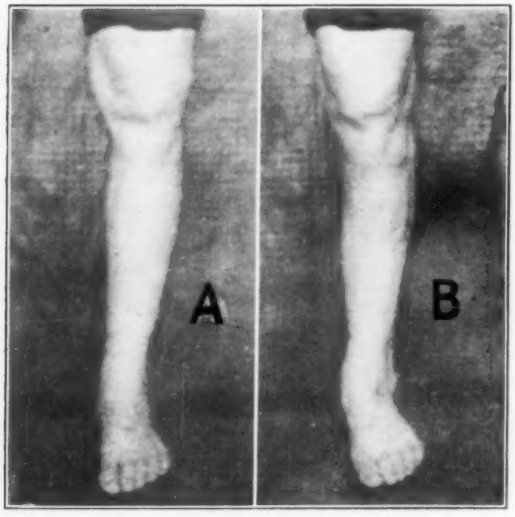

FIG. 2

A. Good weight-bearing line having factor of safety motion in valgus and varus.
B. Poor weight-bearing line having no factor of safety motion in valgus.

to the oft repeated slight trauma due to the habitual use of the foot in faulty weight-bearing lines. It is also known that such a swelling will disappear when the fundamental faults of improper weight-bearing, with the consequent loss of the factor of safety motion, have been corrected.

The fundamental principles mentioned above are:

(1) A joint which is used habitually in a position which has free motion in either direction has a small potential of injury. Such a joint has the so called factor of safety motion.

(2) A joint which has a small or no factor of safety motion has a definite potential of injury.

(3) The best treatment for an injured joint is: first, to correct the weight-bearing lines in order to regain the factor of safety motion; and then to be sure that function is carried out in good weight-bearing lines.

How do these principles apply to the spine and the question of backache? It will be impossible and unnecessary to take up each section of the spine in applying these principles. It is only necessary to discuss the lumbosacral region, because the same mechanical principles are applicable to all regions of the spine.

In the examination of the spine the first point to be investigated is the position in which the joints of the spine are habitually used (Fig. 3). Is there present the normal amount of the factor of safety motion? In good body mechanics (*A*), in the standing or sitting position, the weight of the body is carried on the bodies of the vertebrae with the intervertebral discs acting as shock absorbers. The articular facets act largely as stabilizers; they are not structurally placed or built to support the whole weight of the body. In good body mechanics the articular facets will be so articulated that there will be a factor of safety motion in either direction. In bad body mechanics (*B*), in the standing position, with the usual lordosis in the low lumbar spine, the weight of the body is thrust backward so that it comes on the posterior half of the vertebrae and especially on the articular facets. In such a position the factor of safety motion in the direction of extension must be absent. In the sitting position or in the forward bending position, in bad body mechanics, the weight of the body is changed more to the front part of the bodies of the vetebrae and the articular facets change their positions so that the factor of safety motion in the direction of flexion must be absent. In either of these two positions, extension or flexion, the strain from the weight of the body must come on the joints of the articular facets at the extremes of their range of motion which, as said above, is a potential of injury. This potential of injury, which means stretched and relaxed ligaments, must be compensated for by muscular action or by motion elsewhere in the spine or extremities. If this necessary compensatory action, which is largely reflex, does not function quickly enough—as in lifting or in sudden unexpected motions—there is possibility of acute injury to these joints or to the muscles in this region. Such possibility of injury is, of course, greatly increased if the general condition of the

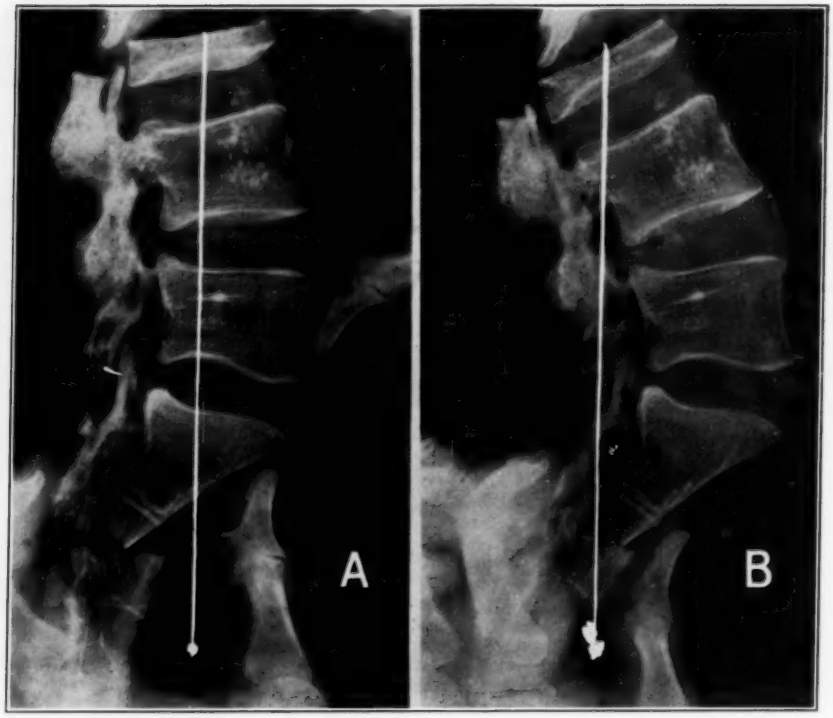

FIG. 3

X-ray of lumbosacral spine.
A. Good body mechanics. Weight carried on the vertebral bodies.
B. Poor body mechanics. Spine in full extension. Weight carried mostly on the articular facets.

patient is one of marked fatigue, or if there is an infection present. The quickness of the response of this compensatory action must also be affected to a greater or lesser extent by the innumerable slight strains caused by habitual faulty body mechanics, none of which strains amount to much, but the sum total of which leads to a chronic state of fatigability.

The anatomy of the vertebrae in the region of the articular facets is particularly interesting from the point of view of symptoms and treatment (Fig. 4). The joints between the articular facets are true joints with capsules, ligaments, and synovial membrane. These joints form a very considerable part of the posterior wall of the intervertebral foramina (*X*). The position of extension (*B*) in the low lumbar as well as in the cervical region decreases the size of the intervertebral foramina (*X*), while the position of flexion (*A*) increases it (*X*). An injury to the joint between the articular processes, therefore, because of the consequent exudative and inflammatory reaction, must still further decrease the size of the intervertebral foramina in the region of the injury. It is, therefore, possible that the combination of the effects of the extreme extension of the lumbar spine, in addition to the swelling from the irritated joint, may cause pressure on the nerves or blood vessels in the intervertebral foramen with the subse-

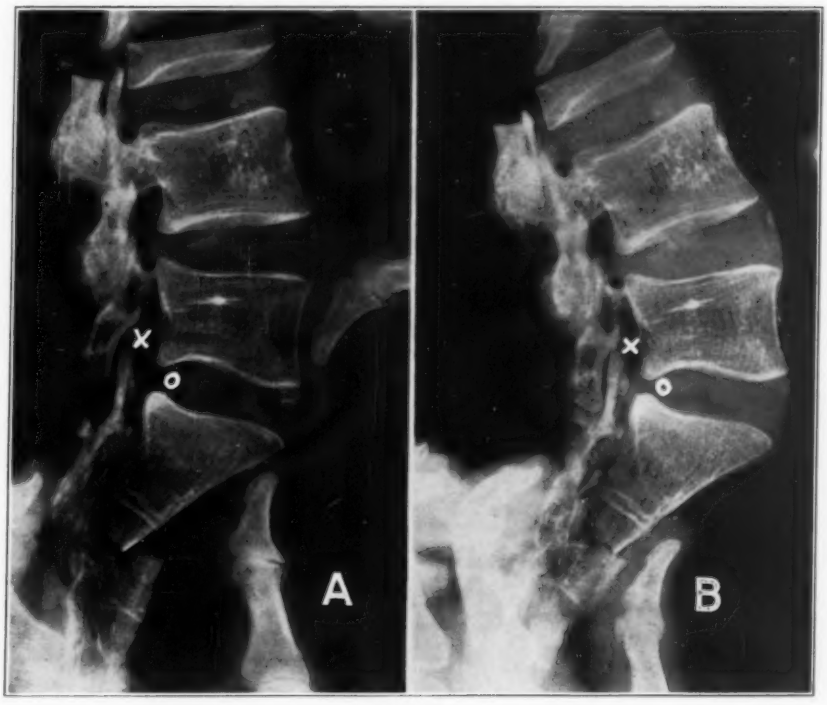

FIG. 4

X-ray of lumbosacral spine.
A. Good body mechanics. *B*. Poor body mechanics.
Note that the intervertebral foramen (*X*) is considerably smaller in poor body mechanics. Note that the intervertebral space (*O*) is narrower posteriorly and wider anteriorly in *B* than in *A*.

quent symptoms of referred pain. As the swelling from the injury may not reach its maximum for some hours after injury, the painful symptoms may not occur for as long as twenty-four hours. The original injury may not have been severe enough to cause more than temporary symptoms but the loss of the factor of safety motion, due to the faulty body mechanics (Fig. 5), makes possible innumerable strains and slight injuries, the sum total of which, added to the acute injury, can fully explain the delayed symptoms. Could these latter slight strains have been eliminated, as is entirely possible by good mechanics or by immediate bed treatment, the delayed symptoms could have been prevented.

The conservative treatment of backache is based on a knowledge of the fundamental mechanical principles stated above. The first requisite of such treatment is rest, and the second is function in the correct position.

In the treatment of a sprained ankle, the combination of rest and function is used as soon as possible after the injury. If the strain is severe enough, the treatment is complete rest until the inflammation has quieted down, followed as soon as possible by function with strapping to prevent further injury. The strapping is always applied to keep the foot from

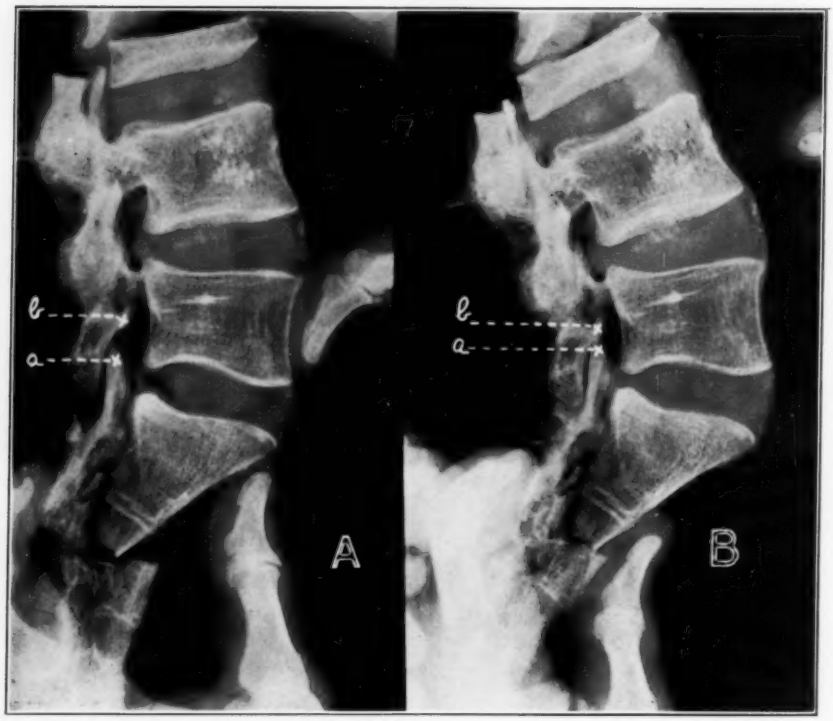

FIG. 5

X-ray of lumbosacral spine.

A. Good body mechanics. *B*. Poor body mechanics.

Note the change in the positions of the articular processes. In extension (*B*) the tips of the articular facets (*a*) are in contact with the bases (*b*) of the opposing process. In *A* there is considerable space between the tips and the bases of the processes. This separation would be much greater in a fresh specimen.

getting into positions which could cause further strain. If the injury is not too severe, immediate function is begun with strapping for protection.

The same method of treatment is equally important and efficient with backache. It is, however, more difficult to carry out and requires more knowledge and patience. The following is an outline of the treatment of a man who had suffered off and on for ten years with pain in the back and alternating sciatica. At first the attacks were infrequent but as time went on they became more common, until he was unable to ride in an automobile or lift anything or at times lean over to put on his shoes without getting a catch in his back. As he was a prominent man, he had had many opinions, the majority of which were for the operative method of treatment.

This picture (Fig. 6) shows the first and most important point in the examination. This man's habitual position of use of his body was at the extreme range of the motions of his spine, particularly in the low lumbar region. It was noted, as is so common in habitual faulty body mechanics, that all of the motions of the spine—particularly flexion—were begun in

the low lumbar region which, of course, puts extra strain on this part; also, when the motions were finished, the body settled back again into its habitual faulty position.

Of equal importance to the story of backache in this man was a long-standing history of indigestion, constipation, headaches, and nervousness, for all of which there had been hospital and sanitarium treatment. The man himself was an unusually intelligent and mentally well-poised individual who realized that his present condition was entirely due to long hours of overwork for many years. Further examination of this man showed a subnormal temperature, a systolic blood pressure below 100 and extreme fatigue. The treatment, accordingly, was planned on the basis of rest and then function. As is not uncommon, this man found it very difficult to stay in bed, as the bed made the back more uncomfortable. Nevertheless, as recumbency is the only way possible to take the weight off the vertebrae and get complete rest, it was the doctor's job to make this position possible. This can usually be done by placing one or two pillows under the knees, thus flexing the hips enough to take the strain off the lumbar spine. This position, of course, can be varied by lying on either side or on the face but the sitting or erect position should be avoided, as it mechanically must put strain on the already strained ligaments or muscles. The face position which tends to cause extension of the lumbar spine may be very uncomfortable, making it necessary to use two or more pillows under the hips in order to obtain sufficient flexion of the thighs. It is a valuable position, however, as it allows the use of hot fomentations to the back to relieve the pain and the inflammation.

FIG. 6

Photograph of patient before treatment. Note that the low lumbar spine is in the habitual position of full extension. Note also the poor mechanics of the rest of the body.

FIG. 7

Photograph of patient after treatment. Note the change in the position of the lumbar spine. Note also the improved mechanics of the rest of the body.

Along with these positions the patient was immediately started on abdominal and breathing exercises, all of which were the first steps in the postural education which would fulfil the second fundamental principle of treatment,—namely, function with the best weight-bearing lines. As soon as possible the stretching out of the dorsal spine and ribs was begun by means of the hyperextended position, as it is obviously impossible to acquire the correct body mechanics by treating

only one part of the body. The next step was the problem of teaching the patient how to use his body in good mechanical alignment when up and around. It would scarcely be possible for such a person, particularly a tired-out patient, to hold himself correctly without some support; and so a brace was planned which, although it could not hold him in the correct position, would help him to so hold himself. This brace was planned not only to give support to the pelvis, lumbar spine, and abdomen, but also to give support to the lower half of the dorsal spine. The reason for this latter support was to put the weight of the upper body more on the front of the lumbar vertebrae and less on the articular facets. The exercises in the meantime had gradually been changed so that the patient had now been shown how to use the body more correctly in the sitting, standing, and bending positions. This picture (Fig. 7) shows the man after he had learned his lesson. His backache and indigestion and other symptoms had cleared up; but as his temperature was still subnormal, and his blood pressure too low, and as he still tired more easily than he should, he could not be considered as entirely cured. It was a relatively easy task to relieve the backache but it will take time to overcome the long-standing fatigue.

From the above outline it can be seen that the conservative treatment of backache consists, not only of treating the back, but also of treating the patient himself. With the above patient the back was only one of the places where the body machine had given way under the combined strain of overwork and faulty body mechanics.

There is no doubt that the disability due to acute back strains, so many of which become chronic, could be very much lessened if the treatment for the back strains could be started immediately after the injury, and if the fundamental principles of conservative treatment were properly carried out. The first principle is rest and this means that the whole body must be put into a position which, mechanically, gives the greatest amount of rest even though, at the outset, it may be difficult for the patient to take such a position. The second principle is function, as soon as possible; but the function must take place with the body in the best possible mechanical alignment. This can only be accomplished by education under the supervision of a medical man who understands what is required for each individual patient.

BACKACHE FROM THE INDUSTRIAL STANDPOINT*

BY PAUL B. MAGNUSON, M.D., CHICAGO, ILLINOIS

Before considering backache from the industrial standpoint, it seems to me, from a rather extensive experience in examining injured workmen, that the mental attitude of the examiner at the start of the examination must be as carefully analyzed as the mental attitude of the patient at the time of examination. In other words, it seems important that the examination be made with the idea of finding what, if anything, is the matter, rather than with the idea of proving or disproving that there is or is not anything the matter.

Pain in the back which is claimed to be due to injury has been a disputed point at law for many years. Attorneys, employers, and workmen have had their choice of physicians to prove their own points, which would seem to indicate, to an impartial observer of the proceedings, that the causes of backache are so obscure and the objective symptoms so difficult to demonstrate that there is always a chance for an argument, and that frequently the most plausible and glib witness on either side is the one desired. Therefore, before we start to examine backs, let us examine our own mental attitude. We are not examining for an employer to prove his point, or for an injured man to prove his contention. We are making an effort to determine whether there is pain in the back, whether this pain could be due to the injury claimed, or whether it could be due to the injury claimed plus some preexisting condition, or whether it is the result of something inherent in the patient's body which has caused pain in the back without injury.

With these points clearly in mind we become diagnosticians, not partisans in a lawsuit. Medical men if anything should always be impartial. They should have good reasons for any statements advanced, and should be able to back up these statements with findings which can be substantiated. On the other hand we must not forget that we are human, that we do not know all the things that can happen and why all the things do happen to the human mechanism that may give pain, and that in the back especially there is a complexity of anatomy which makes careful analysis as necessary as acute observation. It would seem necessary, too, that a man who examines a back from the industrial standpoint should have had much experience in examining backs in private practice, because of the psychological differences in the two classes of patients. The patient who comes to the doctor and pays a fee for an opinion and treatment, usually lays all his cards on the table face up. He comes with the idea of telling the truth and the whole truth, with nothing held back or covered up, because he is seeking relief from his symptoms. The doctor, therefore, is

*Read at the Annual Meeting of the American Orthopaedic Association, Memphis, Tennessee, April 16, 1931.

able to judge whether the symptoms complained of are real, and to fit the physical findings to the symptoms, thereby gaining knowledge of the problem which cannot be gained from a one-sided examination.

In my experience the true malingerer is infrequent in industrial practice. It is true that many patients exaggerate their symptoms. This is on the same basis that the claims department and the company surgeon minimize the symptoms. The patient is simply starting with a high bid, as the company is starting with a low bid, so that a fair adjustment may eventually be reached.

We must have in mind also that the claims department depends on us for information. If an examining physician says that an injured workman is exaggerating his symptoms or malingering, the claims department can only follow the advice of the man in whom they have confidence—the doctor—and many injustices have been wrought on this side of the case as well as on the other side. Fairness, justice, and honesty in these examinations, with the benefit of the doubt thrown in the patient's favor, it seems to me, is the only fair mental attitude. In all my industrial experience, which was ended several years ago but which for fifteen years was fairly extensive, I have never come in contact with an employee of a corporation who did not keep his agreement to stand by the opinion rendered in an examination. It is true they want to be as sure as possible that the opinion is correct and, if they get conflicting opinions from different medical men, it is only natural that some doubt is raised in their minds. Therefore, in reporting examinations, especially in back cases, the examiner should set down definite reasons for his findings—whether for or against injury—and analyze the case so that the attorneys who read the report will know what the doctor's mental processes are and why he has arrived at certain conclusions. By this, much misunderstanding can be avoided and harmony can be promoted between employer and employee; many times harmony is disrupted by conflicting medical opinions.

THE EXAMINATION

The system of examination which has been developed after many back examinations may be of interest. The clothing is removed. With the patient standing with both feet squarely together and the arms at the sides, note is made of whether there is any abnormal curve in the spine, or any deformity. Muscle spasm is looked for and the back muscles are felt from top to bottom to see whether there is any difference in tone. The patient is then asked to bend to the right, and this includes bending of the head to the right. It is noted whether the curve begins at the lower part of the spine and whether there is any segmental limitation of motion.

The patient is asked to put one finger on any point of pain that he may have, and this point is marked with a skin pencil. The opposite motion to the left is then requested, the above points noted, also whether there is

any difference in the curve of the spine at any point or as a whole, and whether there is any difference in the total degree of flexion on opposite sides. The patient is again requested to indicate with one finger any points where there is pain. Flexion obliquely to the right and then obliquely to the left are then requested, and again observation of the curve, muscle spasm, and indication of points of pain are noted.

These motions are reversed and the patient is requested to hyperextend backward to the right and then to the left, and the same questions are asked; then straight forward flexion and straight backward hyperextension. All the indicated points of pain are noted on the examining chart and all the points of pain are marked on the patient's skin.

We then start at the top of the spine and with the thumbs or fingers, preferably the thumbs, go down the spine over the spinous processes and then on each side of the spinous processes, asking the patient to state when a tender point is reached, and the tender points are again marked with the skin pencil—in a different color this time—and the findings are noted on the chart.

The general physical examination is then started. The nose, throat, teeth, heart, lungs, abdominal viscera and prostate are gone over and the history of the case carefully taken. The patient's habits are gone into, the amount of food, the kind of food; the other joints of the body are examined to see whether there is any enlargement or signs of arthritis. Then the patient is requested to stand again and the examination of the back is repeated, notation being made as to whether the points of pain and tenderness correspond to the previous examination. It is a well known fact that an injury to a muscle, tendon, joint, nerve, or other tissue does not move; and it can be safely assumed, therefore, that even in the absence of very marked objective signs, if the patient has pain where he says he has on first examination, it will appear reasonably close to that point on the second examination. Slight variation of course can be made, but when the points do not check up reasonably well a suspicion may arise.

The patient is again requested to be seated, or an examination of some other part of the body—usually the reflexes and feet—is made and noted on the chart. Should the second examination seem to vary much from the first, it is well to use what I call a pressure meter to estimate the amount of tenderness in the various points complained of. This instrument was devised to register in pounds

FIG. 1

Pressure meter, an instrument for measuring sensibility to pain in examinations of the back.

the amount of pressure put on the instrument. It is simply a spring-scale plunger with a padded ball on the end, the pressure being recorded by a sliding ring which remains in place after a given amount of pressure has been put on the ball.

In the third examination of the back, the tender points that have previously been marked are recorded and the number of pounds of pressure which causes pain. If there is a complaint of pain on one-half to one pound pressure, it would seem reasonable to suppose that the point was extremely tender and yet, if this point varies from time to time in its location or if the patient can put a stretch on the tissues involved in such a tender point when he flexes, without exactly locating this tender point, it may be assumed that it is not as tender as the patient says. If the examiner is forceful and entertaining and inquisitive all at the same time, the patient's attention may be diverted. For instance, the examiner can examine one part of the body with one hand, focusing the patient's attention to this point, and at the same time can put the pressure meter over a spot which on previous examination elicited a complaint of pain on one-half pound pressure, and if, with the patient's attention diverted, the operator finds that he can put twelve or fifteen pounds' pressure on this point without complaint from the patient, then again one may assume that it is not as tender as the patient claims it to be. In other words, if the examiner realizes that certain muscles are put on a stretch with certain definite movements, that certain joints have pressure exerted on them with certain other movements, that some movements bring out tenderness in muscles and ligaments and others in joints and nerves, it is not a difficult matter to make a deduction as to whether there is real pathology or not, in spite of the fact that there are no casual objective symptoms.

On the other hand, we must remember that there are two separate and distinct groups of ligaments in the lower back: one anterior to the spine, which cannot be felt from the posterior surface, and which will not give tenderness but will give pain; and the posterior group, which can be felt, although also covered with a heavy layer of muscles and attachments. Through these anterior ligaments and over them run the lumbar and sacral nerves; and an inflammatory condition, which may be purely traumatic, or traumatic plus infectious, or toxic, will cause pain without giving any tenderness. The inflammatory conditions in the anterior ligaments and joints, in my opinion, give more symptoms of referred pain down the legs than those in the posterior.

There are other causes to be looked for in these cases of industrial back pain—the patient's age, his general state of health—and when I say age I do not mean years, but the age of his joints and ligaments, which may have aged much faster than his years because of hard labor, poor food or the wrong kind of food, poor elimination, exposure, infection, or toxaemia which have not been taken care of. It must not be overlooked that many of these patients have toxaemia, either intestinal or metabolic, and many of them have chronic infections; that muscles and ligaments and bones immediately in contact with the attachment of muscles and ligaments, as well as joints, are favorite places for the production of infection and toxaemia; that when this occurs the elasticity of the muscles and ligaments

diminishes and they are more easily injured, and when injured the disability lasts longer than it does with normal tissue.

In my experience, the great majority of patients who have back pain of any magnitude as a result of comparatively slight injuries are over forty years of age, the time when the wear and tear of life is beginning to tell, and we should not approach these cases as bone and joint men but as diagnosticians, because examination of the whole organism is necessary to determine the causes and remove the contributing factors. My experience has shown that diet, a large increase in fluid intake, elimination through the bowels, skin, and kidneys, and rest of the injured part are important considerations in the treatment of these cases. When I say rest I do not mean simply not working, I mean the real rest that comes from a horizontal position, because the lower back is a fulcrum upon which every motion of the body takes place. The body above this point is one arm of the lever and below is the opposite arm of the lever, and no cast or brace can remove the weight that is carried or prevent the shocks that are sustained by the lower back in any kind of motion in an upright position. The ligaments in the back are not different from the ligaments in any other part of the body, except that there are more of them and they have more work to do, and they should be treated in the same way that any other injured ligaments are treated. The fact that some arthritic process shows around the edges of joints does not mean that the back is not injured. It does demonstrate the existence of an inflammatory process for some time, and, because of this, the ligaments supporting the back have had toxic material deposited in them over a period of time and are, therefore, more liable to injury than are the normal.

The interpretation of x-rays in these cases of industrial backache has been the cause of many bitter arguments. I have stated before and will state again that the reason the clinician many times does not make a diagnosis in cases of backache is because the roentgenologist will not tell him what is the matter with the patient. The x-ray is of minor importance in a large percentage of cases in the diagnosis of backache and its causes. There are few individuals who have suffered any of the consequences of living who do not have some evidence of so called arthritis in the spine. We all know that there are many individuals doing daily work with spurs on the joints of the spine or elsewhere. If x-rays of these cases were held up for examination, the patients would be considered unfit for any sort of labor, and yet they have no symptoms. On the other hand, acute inflammatory processes in bones, joints, or ligaments do not show. The fact that such a condition shows on the x-ray means that it has been there for a long time and, if the patient has been working for many months, it is certain that he has been working with the same condition that is shown on the x-ray. Therefore, the condition which is causing the trouble must be a more or less acute affair.

In the final analysis, therefore, the man who examines the patient with a backache, which it is claimed comes from some injury, must be a diagnostician of the highest order, not looking at the back alone, but taking into consideration everything which might cause pain in the back, and evaluating the symptoms with fairness and without bias.

CONGENITAL ELEVATION OF THE SCAPULA

(Sprengel's Deformity)

BY ROBERT PATTERSON, M.D., F.A.C.S., KNOXVILLE, TENNESSEE

The author has seen very few reports of successful operations upon adults for congenital elevation of the scapula (Sprengel's deformity).

The following case report is submitted as an example of what may be accomplished in extreme cases of this deformity by operation and physiotherapy.

Arthur S., aged twenty, presented himself for examination May 2, 1931. He had a marked deformity of the left shoulder and chest which he attributed to a fall at the age of six, in which he sustained a glenoid fracture.

Examination showed a typical Sprengel's shoulder on the left side, which was elevated two inches or more above the right shoulder. The latter appeared to be higher than normal. He had a very thick neck transversely. He could easily touch the top of his shoulder with the side of his neck. Both clavicles were comparatively straight but prominent, and the upper chest was depressed. He had normal movements of the arm at the shoulder, but all of those in which the scapula participated were absent. There

FIG. 1
Patient before operation.

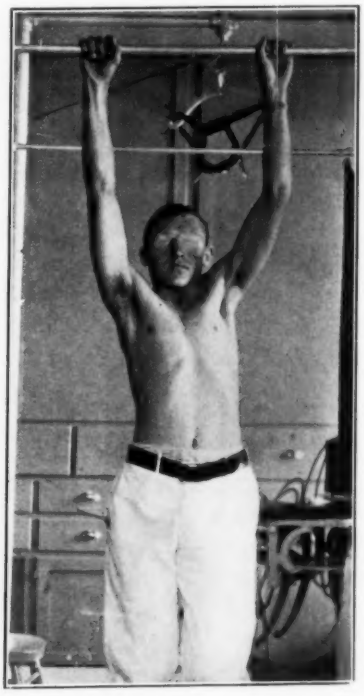

FIG. 2
After operation.

FIG. 3
Posterior view after operation.

FIG. 4
Anterior view after operation.

was no movement of the scapula. The upper and posterior edges stood out prominently and a bridge of bone was felt extending from the upper inner angle of the scapula to the region of the seventh cervical spine to which it was firmly united. The deformity was most unsightly. He sought relief for this reason and because it was hard to get clothes to fit on account of the projecting bone. In addition to being elevated, it presented somewhat the appearance of a "wing scapula".

Operation was performed on May 22, 1931. The incision extended from the lower angle along the posterior border, curving outward over the supraspinous fossa; another extended from this along the bridge of bone to the neck. The scapula was severed from all structures along the posterior border, and the bridge of bone was freed and removed. This bone appeared to be an extension outward of the angle of the scapula and was one and three-quarters inches wide at the base and tapered off to one inch at its insertion into the spinous process.

The supraspinous muscle was then elevated and the bony fossa exposed. This was found to bend anteriorly, forming almost a right angle to the rest of the bone. It was removed back to within one inch of the suprascapular notch and nerve. The infraspinatus muscle was elevated subperiosteally from the vertebral border, likewise the subscapularis and the seratus magnus beneath. The entire prominent portion of the bone, which was more than an inch thick in one place, was resected. The scapula could then be depressed somewhat.

The romboids were practically absent. There was a round bundle of muscle above and one below the bridge of bone running in the same direction,—evidently a portion of the trapezius. Very little muscle tissue was apparent between the scapula and spinous processes. There was a thick fascial layer. Physiotherapy was begun three weeks after operation and was continued for about seven weeks.

Results: Shoulder movements on July 28, 1931, were as follows:
Abduction, about 100 degrees;
Forward flexion, about 145 degrees;
Backward extension, same as other arm.

Patient can grasp an overhead bar placed twelve inches above the head and twelve inches in front of his body.

The most interesting feature of the case is the fact that the scapula has seemed to gradually descend to its normal position as muscle training has progressed, until at present both scapulae are apparently on the same level.

The scapula moves through about two-thirds of the normal range. The patient is now able to swim and engage in other activities which were impossible before operation.

SPINDLE-CELL SARCOMA OF TENDON SHEATH

Report of a Case*

BY MORRIS B. COOPERMAN, M.D., PHILADELPHIA, PENNSYLVANIA

Although the spindle-cell sarcoma is a relatively common tumor, widespread in occurrence and developing in any situation where connective tissue is found, its origin in a tendon sheath is so unusual that the writer feels justified in reporting a case that recently came under observation.

Tendon sheath sarcomata are rare neoplasms, 107 cases having been reported up to the present time. The majority of these cases, however, belong to the giant-cell variety, a benign tumor which has been fully described by French and German observers under the terms xanthosarcoma and myeloma. Torneaux, in 1913, collected ninety-three cases from the literature; fifty-four of these were of giant-cell sarcoma. Janik, in 1927, added fourteen new cases recently reported; most of these were giant-cell tumors. From a statistical standpoint, therefore, the spindle-cell sarcoma is less common than the other variety. A rather extensive discussion has centered around the latter because of its peculiar histologic and chemical characteristics, in which trauma and some peculiar disturbance in lipoid metabolism seem to be the exciting factors. It is of interest to note that a number of authors deny the neoplastic quality of this tumor and regard it as a form of granulation tissue (Fleisig, Broders, and Albertini).

The spindle-cell sarcoma of a tendon sheath occurring in adults is a relatively benign growth, particularly when it is encapsulated.

The case under discussion occurred in a young woman after a minor injury to the foot. The tumor, originating in the tendon sheath of the flexor brevis digitorum, was of about eight months' duration.

M.U., female, aged twenty-one, occupation—salesgirl, entered the Mt. Sinai Hospital November 24, 1930. Her chief complaint was swelling of the right foot and inability to bear weight. About a year previously she sustained an injury to the right foot by falling from a ladder, a distance of about three feet. Very little attention was paid to this injury, but several days later she began to complain of pain and stiffness in the foot and ankle which was treated by strapping. Two months later she noticed a small growth underneath the outer border of the right foot which was tender to pressure and painful on walking. Various treatments were instituted without affording her very much relief. Her disability increased and the tumor grew larger. She continued at her work but found it more and more difficult as time went on.

An x-ray examination, five weeks prior to her admission to the hospital, showed a soft-tissue tumor but no bone involvement. Two weeks prior to admission an incision into the tumor was made and a small amount of thick, creamy substance was evacuated. Following this procedure the tumor became irritated, completely disabling the patient. Previous medical and family history are unimportant.

*From the Orthopaedic Service of the Mt. Sinai Hospital of Philadelphia.

FIG. 1
Spindle-cell sarcoma of tendon sheath.

FIG. 2
Showing the tumor on lateral aspect of the foot. Note the encapsulation and its point of attachment.

FIG. 3
Tumor has been removed, exposing the tendon from whose sheath it originated.

The laboratory studies were negative and the physical examination revealed nothing abnormal, except that the right foot was deformed by a pear-shaped tumor about the size of a hen's egg, located on the outer aspect. Tracing its outline, it was found to extend beneath the plantar surface, approximately, involving the outer half and encroaching upon the transverse arch. It also grew over the outer border upon the dorsal surface. It was soft and elastic in consistency, fairly well circumscribed, not adherent to the skin, but appeared to be firmly attached to the plantar ligaments from which it could not be dislodged. Over the apex of this tumor there was an area of tissue necrosis, about one centimeter in diameter, with grayish base and ragged edges. This ulcer was the site of the incision. The superficial veins on the dorsal surface of the foot were dilated. The ankle, tarsal, and toe joints were normal. The lymph nodes of the inguinal and popliteal regions were not enlarged.

On November 26, 1930, under nitrous-oxid oxygen anaesthesia, with a tourniquet above the right knee, an incision was made along the lateral border of the right foot, extending from the little toe to the calcaneocuboid joint. Upon retracting the skin and subcutaneous tissue, a grayish-yellow, encapsulated and lobulated tumor came into view. It was irregularly oval in shape and was found to originate from the outer layer of the sheath of the flexor brevis digitorum of the little toe. The tendon itself was not involved, but was surrounded by the tumor mass, which measured, approximately, eight by four by three centimeters. The encapsulation was not well defined beneath the plantar muscles and ligaments of the foot. The tumor was shelled out without much difficulty; the tendon and redundant skin were excised and the wound was thoroughly curetted.

Bleeding was controlled by ligature and hot saline packs. The wound was closed in the usual manner with interrupted catgut sutures; a few strands of silkworm gut were inserted for drainage and a plaster cast was applied from the toes to the knee.

The postoperative course was uneventful, the wound healing by primary union in two weeks. The patient remained in the hospital until December 12, 1930. In view of the histologic findings she received seven deep roentgen-ray treatments after the operation.

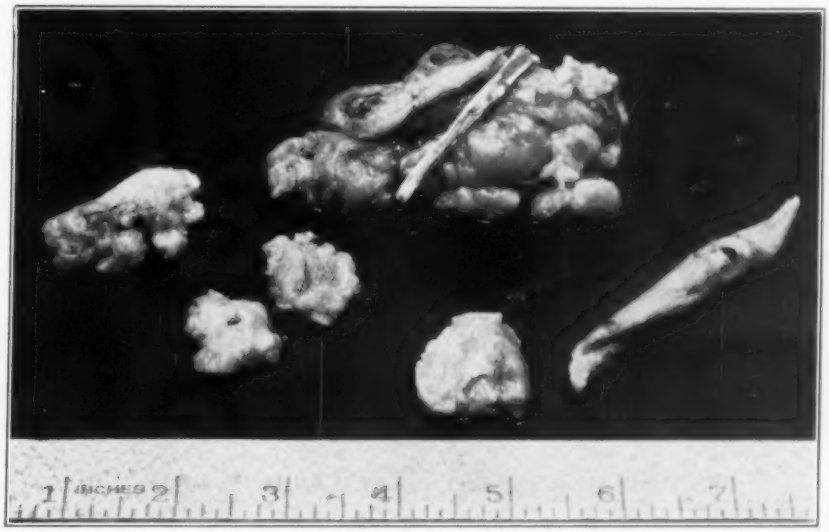

FIG. 4

Tumor and part of tendon with redundant skin. Note the relation of the tumor to the tendon. The largest specimen is the tumor, the others are pieces of plantar fat.

Pathologic report by Dr. B. Gouley. "Macroscopic: One part of the specimen consists of a tendon, five and five-tenths centimeters in length; the second specimen is an elliptical piece of thick, white skin, measuring nine and five-tenths by two centimeters; the third specimen, apparently the tumor, consists of an irregularly oval mass, measuring eight and five-tenths by four by three and five-tenths centimeters, grayish-red in color and encapsulated. On the surface is seen a considerable amount of fatty, lobular tissue which is adherent to a yellowish-white, underlying, firm tissue of semigelatinous consistency. In many areas this tissue shows discoloration as if produced by extravasation of blood.

"Microscopic: Numerous sections of the tumor growth show a uniform, rapid, fibrous hyperplasia invading the surrounding tissue. The cells are moderately enlarged and cell division is noted. In many fields the growth is extremely rich in spindle cells, so closely packed as to make any stroma present appear negligible. Other fields show a fine reticulum, but no myxomatous change is noted. The blood vessels are not numerous but those present are definitely abnormal, exhibiting very thin walls. Giant cells and xanthoma cells were carefully searched for but not found. Pathologic diagnosis: Spindle-cell sarcoma of moderate malignancy."

This slide was reviewed by several other pathologists and they concurred with this opinion.

This patient has been observed in the past eight months and her condition is excellent; there is no local recurrence. X-ray of her chest for metastasis is negative. She has gained in weight and is at the present time in excellent health.

EPIPHYSITIS OF THE PROXIMAL EPIPHYSIS OF THE FIRST METATARSAL AND OF THE FIRST PHALANX OF THE BIG TOE; COINCIDENTAL PRESENCE OF PROXIMAL OR PSEUDOMETATARSAL EPIPHYSES

Report of a Case*

BY M. S. BURMAN, M.D., AND M. POMERANZ, M.D., NEW YORK, N. Y.

The epiphyses for the metatarsal bones appear usually at four to five years of age, that of the first metatarsal appearing first, and being placed proximally at the base of the bone, those of the remaining four at the heads of the bones. Fusion takes place at about the seventeenth to the eighteenth year. Occasionally, and with sufficient frequency so as not to be rare, epiphyses are noted at the bases of the other metatarsals, those for the second and fifth metatarsals being seen most often. These accessory or pseudo-epiphyses, as they are called by anatomists, may be regarded as having no particular significance, save that of an interesting anomaly, or they may be considered as evidence of retarded ossification, endocrinally arisen. Köhler notes that these proximal epiphyses are always present in man in the primitive formation, but that fusion takes place early with the ossifying diaphysis.

Disease of the basal epiphysis of the first matatarsal has been seen only once. No observation of disease of the pseudo-epiphyses has been reported. Wagner noted an isolated, aseptic necrosis (epiphysitis) of the proximal epiphysis of the first metatarsal, the etiology, as usual, being assumed. He failed to comment on the similar change in the proximal epiphysis of the first phalanx of the big toe bilaterally. One of us has observed in the last few years at least six cases of similar changes in the proximal epiphysis of the first phalanx. The case here presented shows bilateral disease of the proximal epiphyses of the first metatarsals and first phalanges of the big toe (epiphysitis), associated with proximal or pseudo-epiphyses of the second, third, fourth, and fifth metatarsals, bilaterally. The association is most probably incidental, and not significant.

CASE REPORT

Case B 10022, M.H., a boy, aged four, was seen in the Out-Patient Department of the Hospital for Joint Diseases, May 20, 1930, because of pain and swelling of the feet. The patient had had a tired feeling in his feet for two years and could not walk distances well. In the past two months, he had had occasional pains in the feet, and transient swelling of the heels and ankles, more marked on the right side. These swellings had been noted also in the lower lip, in the lower part of the left ear, etc., and were sometimes accompanied by a skin rash, which usually followed the oral administration of

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FIG. 1-A

Anteroposterior view of feet of patient described in text. X-ray taken May 21, 1930.

aspirin or sodium salicylate. There was no history of injury. General examination was negative, except for the presence of hypertrophied tonsils and a loud systolic murmur at the apex of the heart, transmitted to the axilla. Temperature and pulse were normal. The child appeared in good health. The child walked naturally, with no limp. The feet were slightly pronated, with some toeing-in on walking. All motions of the feet were normal. No swelling of either foot was seen. There was no pain and no tenderness anywhere in the feet, and very definitely none over the bases of the metatarsals.

A blood Wassermann and a tuberculin test were not done.

Roentgenographic findings. The first set of x-rays, taken May 21, 1930, showed the presence of the proximal epiphyses of the metatarsals bilaterally, at the bases of the second, third, fourth, and fifth metatarsals. These were partly fused to the diaphysis and showed no sign of disease. The distal or normal epiphyses, at the heads of the metatarsals, were also present, but less distinctly seen; that over the second metatarsal head was seen divided in two, on both sides. The proximal epiphyses of the phalanges were all present. The development of both scaphoids was normal, and no disease process was present in them. Our interest centered about the proximal epiphyses of the first metatarsals and of the first phalanges. The phalangeal epiphyses were compressed anteroposteriorly, the interarticular distance being increased. Definite condensation, with little rarefaction, was noted,—a process similar to Köhler's disease of the scaphoid. The epiphyses were seen poorly in lateral view.

FIG. 1-B
Lateral view taken May 21, 1930.

The proximal epiphyses of the first metatarsal showed greater change bilaterally. The epiphyses were wider externally, narrower internally, and compressed anteroposteriorly, more so on the inner side. A definite line of constriction was noted, more on the right side. Condensation of the epiphyses, with slight rarefaction, was present. There was early fragmentation of the inner part of the right proximal epiphysis. The interarticular distance was increased. Laterally, the changes were also well demonstrated.

Another set of plates, taken June 12, 1930, showed the disease process advancing, especially on the inner half of the proximal epiphysis of the right first metatarsal bone.

The patient, during the brief period of observation, was given baking and massage treatments, and corrective shoes were worn. Rest was advised. Little improvement resulted. The mother noted on her second visit that he still complained of pain at times, and that he could not walk distances well. Continuance of treatment was advised and the mother told of the probably self-limited nature of her child's illness.

Examination on April 1931, showed some subsidence of the disease process. The epiphyses of the proximal phalanges of the great toes were somewhat larger and showed a definite diminution in the hypercalcification. The fragmentation in the epiphyses at the bases of the first metatarsal bones had disappeared and the epiphyses consisted of single segments of bone. The osteitis had completely subsided. The accessory centers of

ossification in the distal ends of the second metatarsal bones on both sides had fused and formed one fairly large epiphysis. The epiphyses of the bases of the remaining metatarsal bones showed no essential alteration when compared with the first examination.

This, then, is a case, in an unusual location, of that typical osteochondritic process, known in other sites as Köhler's disease, Perthes' disease, etc.

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GENERALIZED OSTEITIS FIBROSA CYSTICA ASSOCIATED WITH A PARATHYROID ADENOMA

BY T. P. NOBLE, M.D., F.R.C.S., BANGKOK, SIAM

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The association of osteitis fibrosa cystica and parathyroid disease has been recognized for over twenty years, but the discovery by Collip in 1925 of an active parathyroid hormone made it possible to study hyperparathyroidism experimentally. When parathormone—the active principle of the parathyroid glands—is injected into animals, there is produced an increase in the calcium and a decrease in the inorganic phosphorus in the blood, an increased excretion of calcium and phosphorus in the urine, a negative balance of calcium and phosphorus, together with hypotonicity of the muscles. If repeated small injections of this hormone are administered over a period of time, generalized resorption and fibrosis of the bone marrow results.

In 1926 Mandl removed a parathyroid tumor in a case of generalized osteitis fibrosa cystica. Following the operation there was a prompt and permanent clinical improvement. This appears to be the first demonstration of spontaneous hyperparathyroidism, and is all the more interesting in that there was no evidence of a tumor by palpation of the neck prior to operation. Since that time several cases have been reported, and extensive reviews of this subject have appeared by Hunter in England, and by Barr and Bulger in America.

The following case shows that this disease occurs in the East as well as in the West.

CASE REPORT

History.—A Chinaman, aged forty, a farmer by occupation, was admitted to the Siriraj Hospital, Bangkok, on April 23, 1929. He complained of pain and swelling of his right arm with inability to lift it. Twenty years before he accidently fell in a crowd and was trampled on. There was no fracture at that time, but since then he had had pain and weakness in the right arm and had been unable to carry on his duties as a farmer. He contracted syphilis many years ago while in China.

Examination.—The patient was thin and anaemic, but was able to get about quite well. The right shoulder drooped and the lower half of the right arm, forearm, and hand were swollen. The arm was held in adduction with the elbow flexed. There was crepitus and preternatural mobility at the junction of the middle and lower thirds of the right humerus, without any history of recent injury. No other bony swellings were detected. The Wassermann and Kahn tests were strongly positive and the urine showed a trace of albumen.

X-ray Examination.—The right humerus showed considerable decalcification and a pathological fracture was present at the junction of the middle and lower thirds of that bone. There were numerous irregular expansions of the cortex of the humerus with cystic formation.

A diagnosis of fibrocystic disease of bone in a syphilitic patient was made and intensive antisyphilitic treatment was started, together with irradiated ergosterol and ultra-violet light. The right arm was fixed in a plaster-of-Paris splint.

May 1929.—X-ray showed the fracture of the right humerus to be slowly uniting.

July 1929.—An oval swelling about the size of a hen's egg and bony in consistency had appeared on the upper third of the right tibia. X-ray showed decalcification of the tibia and fibula with a thinning of the cortex and cystic formation in that area.

August 1929.—At the beginning of the month the patient felt pain in both thighs and began to have increasing difficulty in walking. On the tenth of the month, while trying to lift his left leg over the edge of the bed, spontaneous fracture of the left femur took place.

September 1929.—The right humerus had now united, although the irregular expansion of bone could be felt with egg-shell crackling. On the sixth of this month, while trying to lift his buttocks on the bed-pan, he fractured his right femur.

October 1929.—A fracture again appeared at the original site in the humerus. The patient's general condition remained much the same. The three fractures had not united.

January 1930.—The swellings on the right tibia had become larger and another swelling had appeared on the fourth rib, on the right side at its junction with the cartilage, followed by similar swellings on the skull and phalanges of both feet.

February 2, 1930.—Blood calcium twelve and eight-tenths milligrams per 100 cubic centimeters.

February 13, 1930.—Blood calcium fourteen and two-tenths milligrams per 100 cubic centimeters.

The patient had now become very helpless and so miserable that he had threatened suicide more than once. In view of the increasing cystic formations in the bones, the hypercalcaemia and the failure of the fractures to unite in spite of repeated courses of antisyphilitic treatment, the case was considered to be one of hyperparathyroidism due to a parathyroid adenoma, although repeated examination failed to reveal a tumor in the region of the thyroid gland.

November 1930.—Under local anaesthesia the neck was explored for a parathyroid tumor. Both lobes of the thyroid gland were exposed but no parathyroid tumor was discovered, although at a later date the postmortem examination revealed the presence of one. The patient stood the operation well in spite of the difficulties attendant on three ununited fractures. On the third day after operation the patient developed bronchopneumonia and died.

POSTMORTEM EXAMINATION

The body was thin and emaciated with marked atrophy of all the muscles. Two small nodular masses were felt on the ribs. Both femora were fractured with little or no attempt at bony union. On removing the right femur it was found that the head and condyles still maintained their normal appearance; but the shaft, seven and five-tenths centimeters below the neck, had a fusiform swelling, and the compact bone was destroyed and absorbed. Longitudinal section of the shaft showed blood clots in its interior, a small quantity of yellow bone marrow and strands of firm, gray tissue. These were enclosed in gray, fibrous periosteum.

In the neck there was an oval, encapsulated mass which measured two by one and eight-tenths by one and five-tenths centimeters and was loosely attached to the upper and posterior aspect of the left lobe of the thyroid gland. On section it appeared to be a parathyroid tumor which was composed of gray tissue in the upper part and soft, yellow tissue in the lower part. The thyroid was normal in position, size, and consistency. The trachea and oesophagus were normal.

The right lung weighed 315 grams and showed slight oedema. The lower lobe contained irregular areas of gray consolidation. The left lung weighed 460 grams, was oedematous, and on section presented many small grayish elevated firm areas.

The right kidney weighed 105 grams, the cortex had an irregular gray area of scar tissue to which the capsule was adherent. The medulla and pelvis contained a few small calcified masses. Left kidney weighed 100 grams and showed similar lesions.

Microscopic Examination.—The character of the cells of the parathyroid tumor was of three types: First, the normal parathyroid tissue cells were seen in irregular patches here and there. These cells were round, regular in size, and had pale pink, finely granular cytoplasm. The fibrous tissue supporting the blood vessels was thin and moderate in quantity. There were irregular spaces of variable size, lined with endothelial cells and filled with pink-staining homogeneous coagulated fluid. The second type was composed of polyhedral and cuboidal cells, larger than normal parathyroid tissue cells; their cytoplasm was abundant, coarsely granular, and strongly acidophilic. The nuclei were usually round, vesicular, and occasionally showed hyperchromatism, but presented no evidence of mitosis. These cells were closely arranged into irregular anastomosing columns, supported by a moderate amount of fibrous stroma containing blood vessels. At one point they secreted pink-staining homogeneous material in which were a few crystals of cholesterin. The third type consisted of intermediate cells continuous on the one hand with the normal parathyroid tissue and on the other with the adenomatous tissue. They differed from normal parathyroid tissue cells in that their cytoplasm was more granular and they stained more deeply with eosin. In places the tissue was separated into nodules by thick bands of partially hyalinized connective tissue, here and there infiltrated with yellowish-brown granules. Sections of the ribs were made without decalcification and presented no difficulty in cutting. They showed complete replacement of bone marrow by vascular connective tissue, hemorrhagic in places, and infiltrated with mononuclear cells containing black pigment. Among the connective-tissue cells were many large multinucleated cells suggestive of osteoclasts. In some places these giant cells lay very close to the surface of the bone which contained little or no lime salts.

DISCUSSION

Up to date seventeen cases showing the clinical characteristics of hyperparathyroidism have been described. In twelve of these cases a parathyroid tumor was removed; in two, one or more histologically normal parathyroid bodies were removed; in three, no operation was performed on the neck. In eleven cases careful palpation of the neck, with a parathyroid tumor in mind, did not reveal a growth in that region, but on exploration only two failed to show a parathyroid tumor; in these two cases it may be that the tumor was present but not discovered at the operation. The case under review is an example of this,—the tumor was situated outside the capsule of the thyroid gland and was only revealed by postmortem examination. The relationship of the thyroid gland to the parathyroid adenoma is shown in Figures 1 and 2.

The principal complaint of most patients suffering from this disease is pain in the limbs, followed by spontaneous fractures and muscular weakness. X-rays of the bones show a progressive and generalized absorption of calcium salts, associated with thinning of the cortex and the presence of cystic areas. The bones are easily penetrated by the rays so that photographs are generally poor in quality, more especially in the advanced stages of the disease. The blood shows a high concentration of serum calcium and a low concentration of plasma phosphorus. There is an abnormally large excretion of calcium in the urine and a negative calcium balance.

FIG. 1

Pathological specimen showing relationship of the parathyroid adenoma to the left lobe of the thyroid gland.

FIG. 2

Lateral view showing parathyroid tumor on section.

Owing to the hypercalcaemia there are frequently present renal calculi and metastatic calcification in various organs of the body. In the majority of cases, after the removal of a parathyroid adenoma, the levels of the calcium and the phosphorus in the blood and the excretion of the calcium in the urine are rapidly restored to normal, although sometimes there is a temporary hypocalcaemia with subnormal excretion of the calcium in the urine. Latent tetany after operation appears fairly frequently and manifest tetany occasionally occurs, the symptoms varying considerably in severity. These symptoms are at once relieved by injections of parathormone subcutaneously and calcium chlorid intravenously. The symptoms as a rule disappear very soon after operation, but the return of the bones to their normal structure must be a matter of months or years.

Most of the cases of this disease have been treated at one time or another with vitamin D with temporary improvement; this raises the serum calcium, but its action is probably quite independent of the parathyroids. The increase of calcium in the blood after the administration of vitamin D is due to a greater and more complete absorption of ingested calcium. The parathyroids, on the other hand, increase the serum calcium by liberating it from the bones. One might assume that vitamin D would assist the parathyroids in maintaining the serum-calcium level and should be a very useful drug during the period immediately succeeding the removal of a parathyroid tumor.

CONCLUSIONS

1. A case of generalized osteitis fibrosa cystica, due to a parathyroid adenoma, is described, occurring in a Chinaman. The parathyroid tumor was found neither by clinical examination nor at operation, but was revealed at postmortem examination.

2. It is advisable to recommend surgical exploration of the parathyroid glands in cases of generalized skeletal decalcification if associated with hypercalcaemia.

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HERNIA OF THE KNEE JOINT (BAKER'S CYST)

BY EDWARD K. CRAVENER, M.D., SCHENECTADY, NEW YORK

Hernia of the capsule of the knee joint is an old subject, but an exhaustive search of the literature reveals very few articles bearing directly on it. It was first described in English by Mr. W. Morrant Baker in the Report of St. Bartholomew's Hospital in 1877[1]. Later, in 1885, the report was enlarged and two new knee cases were presented[2].

Mr. Baker states specifically or by implication that these herniae must:

1. Be connected with the joint.
2. Be lined with synovia.
3. Herniate through a normal or abnormal opening about the joint.

In the original paper eight cases are given. Because of the present improvement in diagnostic facilities some might be disputed. Two or three are beyond question.

The anatomy of the knee joint, while compact on the medial, anterior, and lateral sides, presents potential weaknesses in the posterior portion. The capsule is intimately associated with small bursae lying between and under the hamstring tendons where the reflections of the tendons of the semimembranosus and other muscles are not complete. These zones stand as potential hernial openings. Through these protrusion may occur when abnormal conditions increase the joint fluid.

The symptom complex becomes: the hernia first develops through a normal or abnormal opening; it is pinched by reason of the motion of the knee, and presumably more effusion develops,—a vicious circle.

The diagnosis of Baker's cyst is comparatively easy. A small mass can be felt in the popliteal space, either medial or lateral, but usually above the middle half; this fluctuates and is easily compressible. Drainage of the joint and replacement by air will show, in the anteroposterior view of the x-ray, a small cleared area; in the lateral view a bubble-like formation can be seen in the popliteal space.

The treatment of this disorder is: (1) palliative and (2) surgical.

If the condition seems to be entirely secondary to a local condition within the knee joint and causes only minor symptoms, a tight binder with a pressure pad directly over the tumor will help to minimize the disorder.

If the tumor has grown so large as to impinge on the popliteal nerves or to cause oedema of the leg by reason of obstruction of the venous flow, or if it interferes with the arterial supply, then the tumor can be approached from the rear, shelled out, amputated at the base, and the tissues approximated over the original canal.

CASE REPORT

A retired salesman, aged sixty-four, presented himself to the Clifton Springs Sanitarium and Clinic for treatment, complaining of dizziness and pain in the right knee joint. Physical examination showed marked arteriosclerosis and hypertension with blood pressure of 240/120. The liver was enlarged; the body showed signs of general degeneration. The right knee was freely movable save in complete flexion. There was a moderate amount of fluid within the joint. The capsule was not thickened. A small compressible tumor mass was felt on the outer side of the upper popliteal space. The knee was painful after exertion and the patient felt that this tumor was larger after he had walked beyond his usual custom. The joint was drained and injected with air. Tracings of the x-ray are shown herewith. On account of the patient's age and his manifest inability to stand major surgery, a tight elastic bandage was fitted and the patient walked with more comfort.

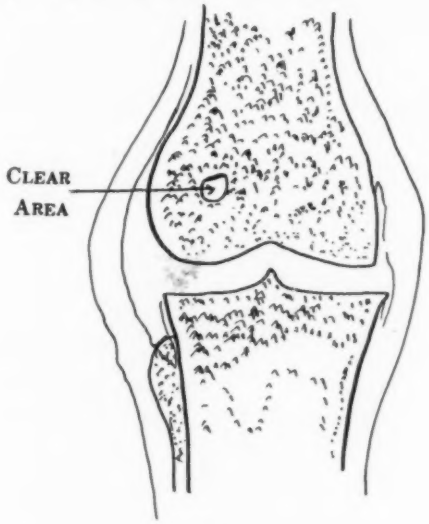

FIG. 1

Tracing of x-ray after air injection.

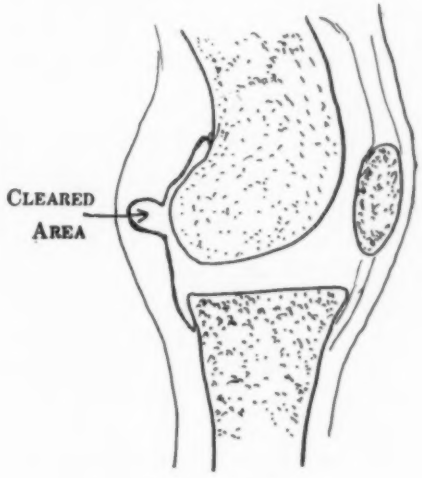

FIG. 2

Tracing of lateral view after air injection.

While this patient had a gross osteo-arthritis and probably derived most of his pain from this disorder, the potential hernia present in the posterior space had become real, due to the effusion into the joint.

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TWO CASES OF UNUSUAL CONGENITAL DEFORMITIES*

BY A. L. CRAIG, M.D., HONOLULU, HAWAII

From Shriners' Hospital for Crippled Children, Honolulu

Among the patients received during the past month in our out-patient clinic were two interesting cases of unusual congenital deformities.

CASE 1. M. A., aged one month, was the daughter of a father, aged thirty, of Norwegian-German ancestry and a mother, aged nineteen, of Hawaiian-Chinese parentage. There had been no other children. Wassermann test in the mother was negative.

Examination showed a well nourished child, apparently of good mentality, with a history of normal delivery. The abdomen and chest were normal. The shoulders

FIG. 1

FIG. 2

*Received for publication, October 6, 1931.

FIG. 3

were normal, but no motion could be obtained in either elbow. The bilateral club hands showed two fingers on the right and three on the left (Figs. 1 and 2). There was a dislocation of the left hip with flexion deformity of the knee.

CASE 2. A. S., a boy, aged one month, was the fourth child of a Portuguese mother and a father of French-English parentage. The mother was thirty-five, the father thirty-six. Wassermann test in the mother was negative. The oldest of the three other children was a patient in a tuberculosis sanatorium.

The delivery of the child had been normal. Examination of the abdomen revealed a large inguinal hernia on the right side. There were bilateral club hands, with no motion at the elbow, and club feet in marked equinovarus (Fig. 3); dislocation of hip on the left side with flexion deformity of the knee.

A DEVICE FOR THE SIMULTANEOUS TRACTION AND COMPLETE IMMOBILIZATION OF THE CERVICAL SPINE

BY J. DEWEY BISGARD, M.D., CHICAGO, ILLINOIS

From the University of Chicago, Department of Surgery, Division of Orthopaedics

The importance of maintaining absolute immobilization with the application of traction to the cervical spine in the treatment of certain fractures and disease processes of the component vertebrae is well recognized. To immobilize effectively this portion of the spine the fixation must include its articulations with the occiput and thoracic cage. This is not accomplished by the procedures commonly used,—such as the Hanflig appliance, traction halters, and the Thomas and turnbuckle collars. For this reason, the device described below and illustrated in Figure 1 was evolved.

With traction applied to the head by means of a sling or halter in suspension, or on a horizontal frame, a plaster collar-jacket is molded snugly about the occiput and chin above and the shoulders and upper thorax below. Two pieces of canvas tape, with buckles attached, are incorporated in the plaster and their free ends are subsequently secured to the head of the bed, which is elevated, and traction secured by virtue of the patient's own body weight.

To permit the jacket portion of the cast to slide upward readily with traction, the plaster below the axillae is cut out widely. Especial attention is exercised to provide adequate felt padding and to cut windows for the relief of pressure over the ears if necessary.

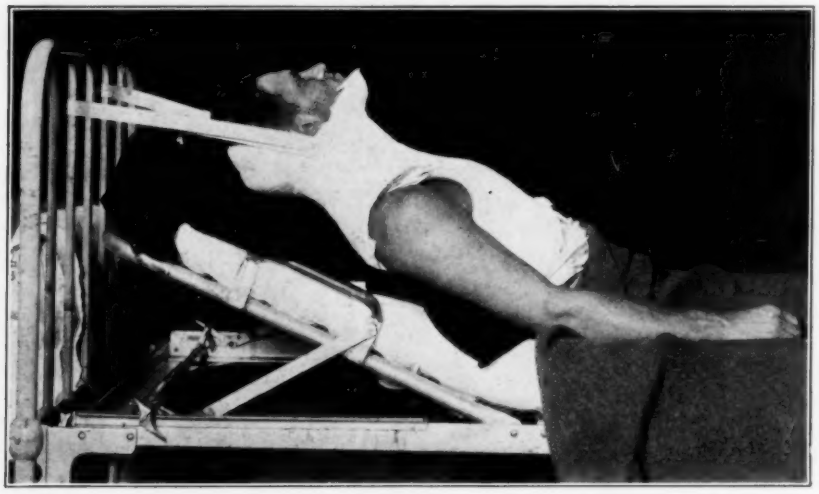

FIG. 1

With a carefully fitted jacket, the patient is surprisingly comfortable. This fact and the advantage of absolute immobilization, combined with the simplicity of its principles of traction, merit its consideration in the treatment of this group of cases. Its functional efficiency is further enhanced by the low cost of construction and the ease of application.

A SUPPORT FOR TRACTION AND COUNTERTRACTION

BY LESLIE V. RUSH, B.SC., M.D., AND H. LOWRY RUSH, B.SC., M.D.,
MERIDIAN, MISSISSIPPI

In the July 1931 issue of *The Journal of Bone and Joint Surgery* (XIII, 609) was published an article by Dr. H. Earle Conwell of Fairfield, Alabama, on "A Thigh-Knee Support for Countertraction". The device herein described is similar in principle to that of Dr. Conwell's and for that reason it is presented as a modification of Conwell's thigh-knee support.

(1) This apparatus serves the same purpose as the Conwell support for countertraction on the knee and thigh when traction is made on the leg and foot (Fig. 2).

The traction and countertraction support. It is made of a piece of band iron fifteen inches long, one and one-half inches wide, and one-eighth of an inch thick. *A* is three inches in length and is turned back one inch upon itself at the extremity (A^1). A slot is cut through each extremity at A^2, one and one-fourth inches long and one-fourth inch wide, for the passage of an inch-wide, web book strap. The band iron is bent to a right angle at *B*. *C* is two inches long. *D* is five inches long and bent into an arc to fit the contour of the leg.

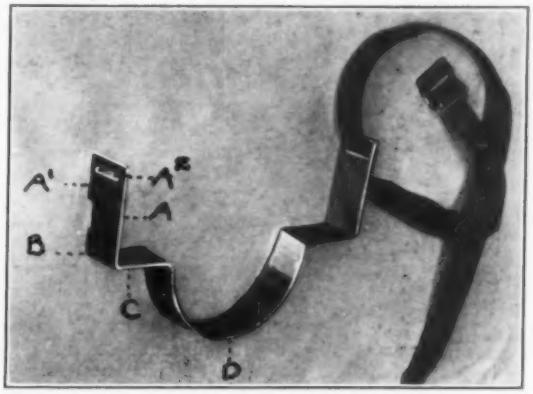

FIG. 1

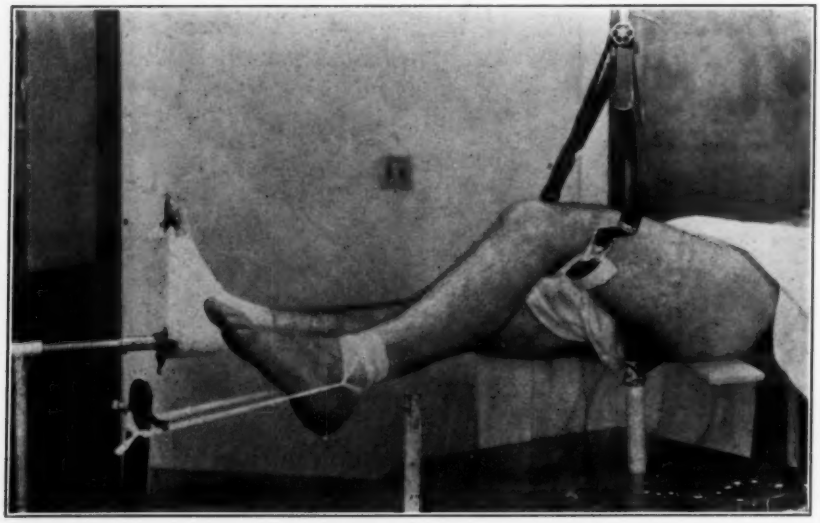

FIG. 2

Shows the apparatus applied on the Albee table for countertraction to the knee and thigh. Web book straps have been passed through the slots of the support and fastened over the horizontal bar on the upright. The support is raised or lowered by adjusting the straps. The leg is protected from the pressure of the iron band by a large felt pad. The cast is applied over the support. After the plaster has set the support is removed, the felt pad left in place, and the resulting window covered with several turns of plaster bandage.

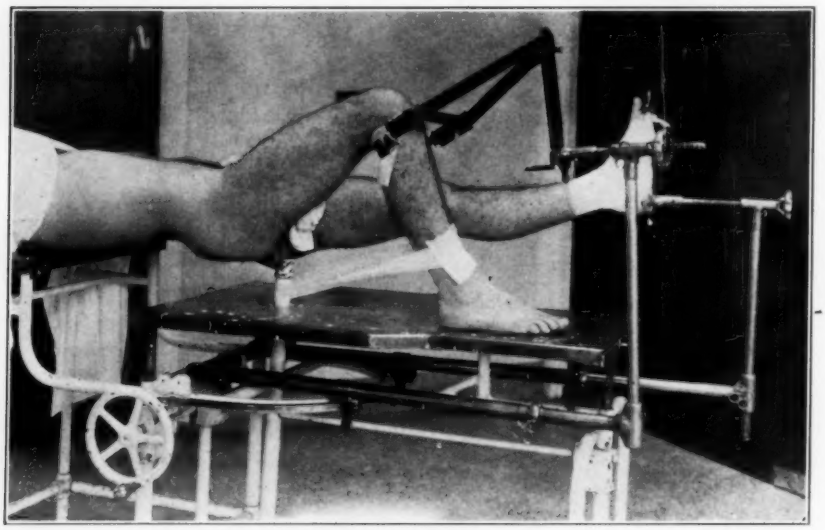

FIG. 3

The apparatus has been applied for traction on the thigh. The leg is here protected with felt. Countertraction is obtained by the perineal upright and by a gauze bandage passed from the sacral support to the lower third of the leg. The plaster cast is applied in the usual manner, the support being removed and that portion of the cast covered with plaster bandage as described under Fig. 2.

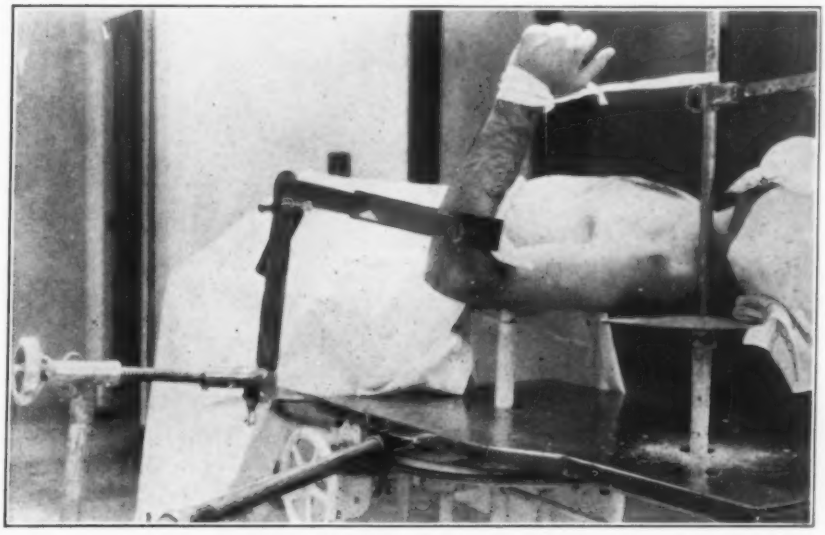

FIG. 4

Shows the apparatus being used for traction on the humerus. The patient has been placed on the body support, the head of the patient being at the foot of the table. The leg traction pieces have been brought out to the extreme lateral position. The forearm is protected with felt. A single web strap has been threaded through the slots and fastened over the foot piece. The wrist is tied to the upright with gauze bandage, so that the elbow remains flexed at an angle of ninety degrees. One assistant exerts countertraction on the sound limb, while a second assistant makes direct traction on the fractured side. The surgeon guides the fragments into position. A shoulder spica is applied. After the plaster has set, the traction piece is removed, leaving the felt in place, and the window is covered with plaster in the manner described above.

(2) It is simpler of construction and of application, and is easily adjusted to any desired height or position.

(3) It is useful for traction on the knee and leg when traction is to be made on the thigh with the hip and knee flexed (Fig. 3).

(4) It is useful for traction on the elbow and forearm when traction is to be made on the upper arm (Fig. 4).

A NEW APPARATUS FOR THE LENGTHENING OF LEGS

BY FRANK D. DICKSON, M.D., AND REX L. DIVELEY, M.D., KANSAS CITY, MISSOURI

The following described apparatus may be useful to those who are interested in leg lengthening.

This apparatus, which we feel is an improvement over that first described by Abbott, replaces the pin traction by the Kirschner wire device. The apparatus is really a combination of the Abbott device and the Kirschner wire apparatus. It is a distinct improvement over the pin method of traction as the wire is much more easily and more accurately inserted and there is less damage done to the bone and soft parts at the points of insertion.

The apparatus consists of a frame, the proximal end of which is made up of a horse-shoe piece (B) which holds the two stationary Kirschner wires (C_1 and C_2). Upon the two side bars (D_1 and D_2) slides the second horse-shoe piece (E) which holds the second two Kirschner wires (F_1 and F_2) in place. Continuous traction is made on the distal fragments of the tibia by the nut G and the spring H, this traction being transmitted to the tibia through the horse-shoe piece E and wires F_1 and F_2. This traction can be varied by the tension of the nut and spring on the side bars. The variable foot piece (J) holds the foot in the desired position.

The operation is performed in the usual manner, an oblique or Z-shaped osteotomy being performed on the fibula. This is followed by a Z-shaped osteotomy of the tibia. The incisions are then closed by layers without

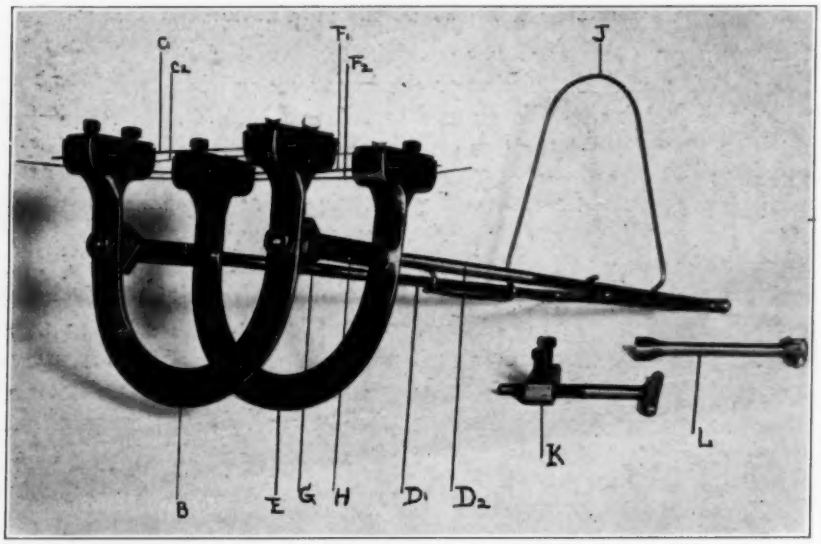

FIG. 1

Showing details of apparatus.

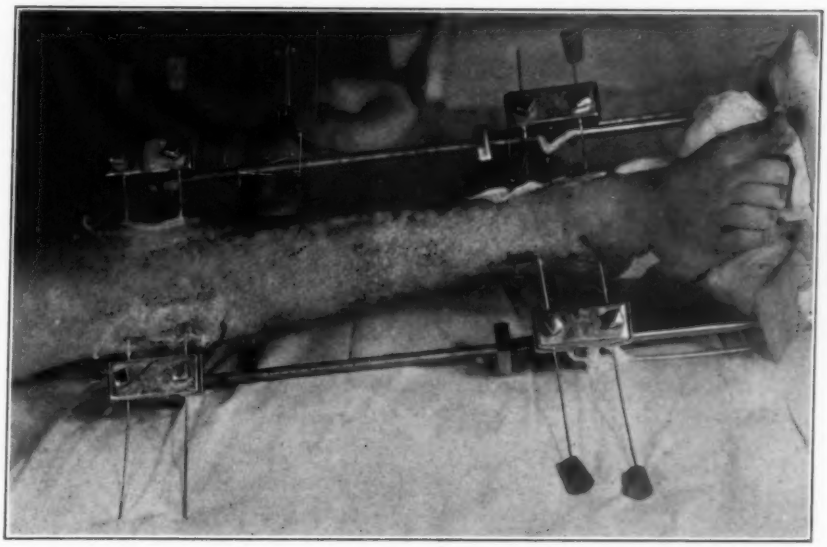

FIG. 2

Anterior posterior view of apparatus after leg has been lengthened.

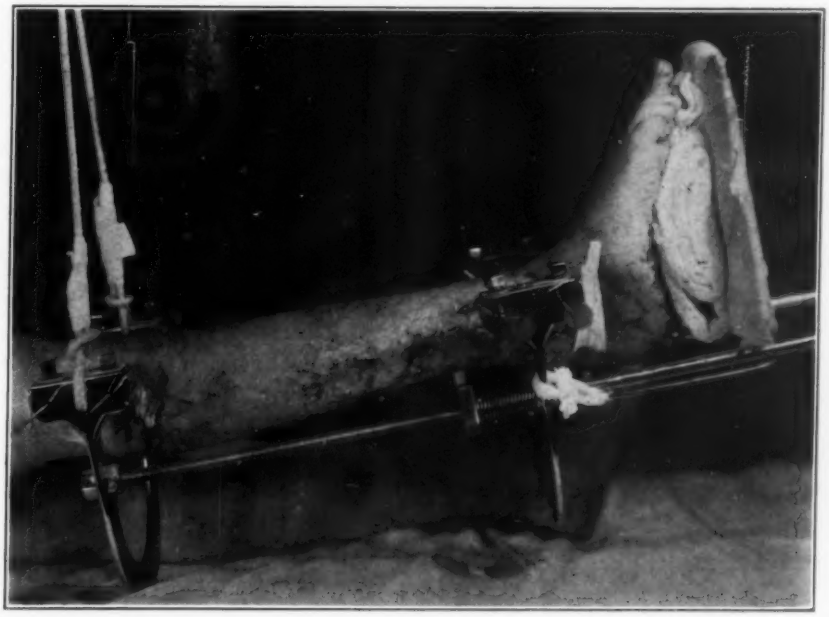

FIG. 3

Lateral view of apparatus after leg has been lengthened.

drainage and a tenotomy on the Achilles tendon is performed if necessary. The Kirschner wires are then inserted, two in the upper fragment of the tibia and two in the lower fragment, just below and above the limitations of the Z-shaped osteotomy. It is very important that these be placed in the same vertical plane and the spacing of the wires can be made accurately by using the base piece of turnbuckle *K*. After the four wires are inserted, the traction apparatus is fitted into place, the four wires being inserted into the grooves of the two horse-shoe pieces. The wires are then made taut with turnbuckle *K* in the usual manner and the wires tightened in place with wrench *L*.

RIGID SIDE BARS IN TIBIA LENGTHENING

BY KENNETH T. YOUNG, M.D., BROOKLYN, N. Y.

This simple adjunct is used after the desired amount of lengthening has been obtained by the method of tibia lengthening described by Abbott.

In each case the exact distance between the four pins is measured on both the inside and outside of the leg. It is necessary to measure each side separately, as there will be a slight difference between the two sides. Taking two pieces of ship steel one inch wide by three-sixteenths of an inch and long enough to extend two inches above the top and bottom pin, four holes are drilled in each to correspond to the positions of the four pins and of the same diameter as the pins. By means of a hack saw, each hole is slotted to the same edge of the steel bar.

With the entire Abbott apparatus in situation, a plaster cast is applied from the base of the toes to the mid-thigh with only the slightest amount of padding possible. The steel bars are then dropped over the four pins and the corresponding sides of the leg, so that each slot fits a pin firmly. The bars are then pushed firmly against the plaster cast. The side bars of the Abbott apparatus with their extension threads are removed, and the plaster cast finished, with the pins *in situ* and securely held in place because they are firmly locked by the rigid side bars which are incorporated in the plaster cast. Anterior and posterior windows may be cut over the tongue and groove of the tibia, so that the development of callus may be followed by a series of roentgenograms.

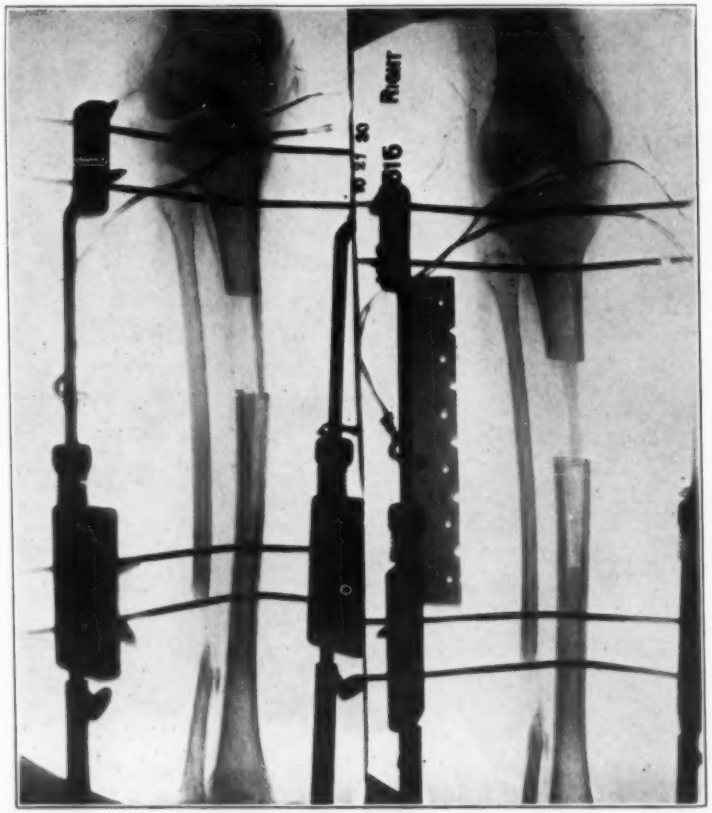

FIG. 1

Case 1. X-ray taken forty-seven days after operation. One and five-eighths inches lengthening (the desired amount). No angulation.

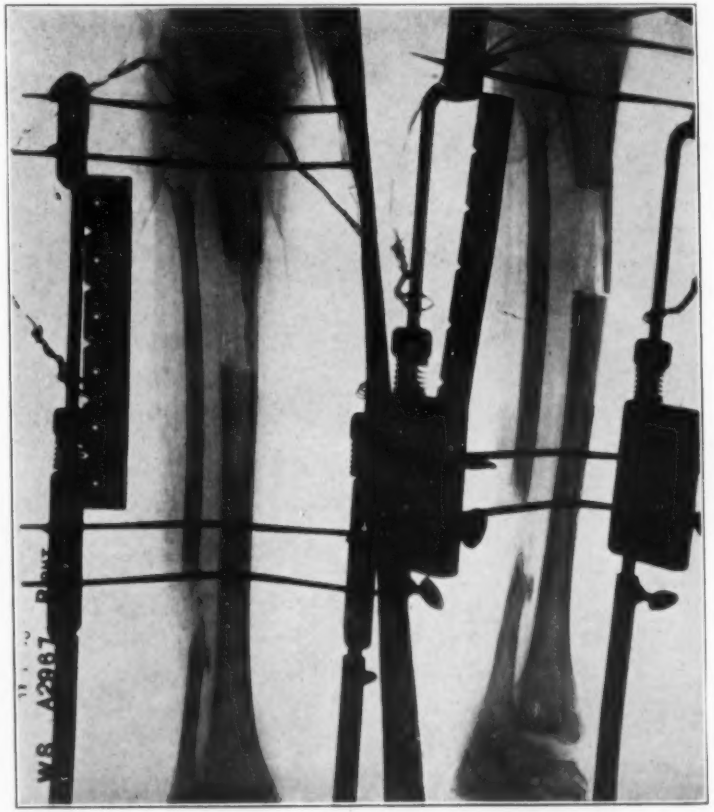

FIG. 2

X-ray taken ten days after Fig. 1. Overlengthening due entirely to action of the springs, as the traction devise had not been turned since previous film. Note the "tongue" has been pulled out of "groove".

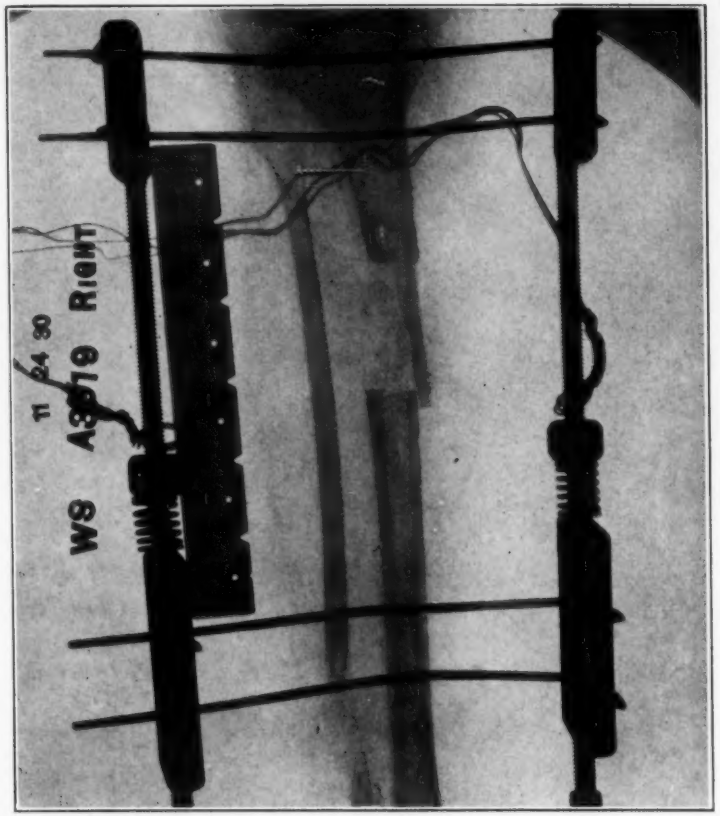

FIG. 3

X-ray taken three weeks after Fig. 2. Springs have been relaxed; measurement again shows one and five-eighths inches lengthening. "Tongue" is now in contact with "groove" but for the first time there is some angulation present.

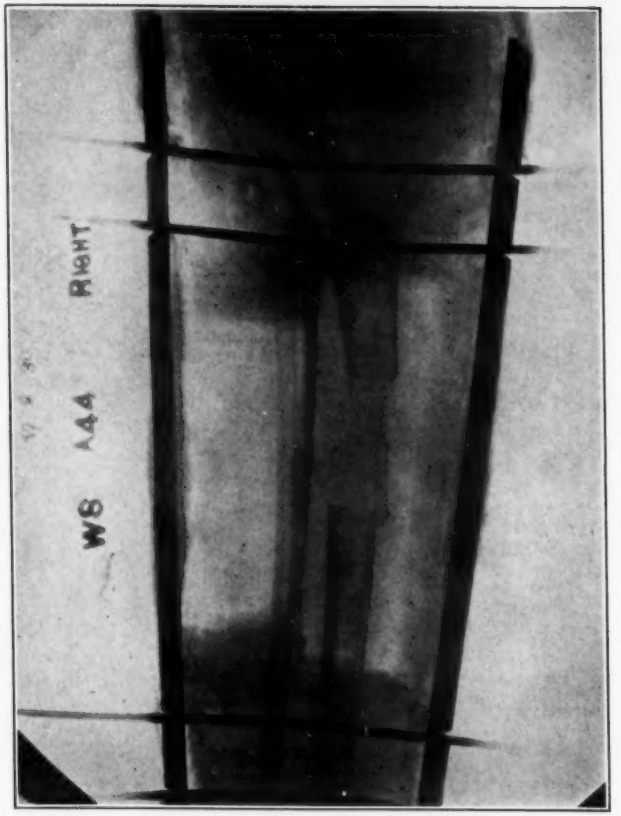

FIG. 4

X-ray taken after application of cast. Rigid side bars in place locking the four pins. "Tongue" and "groove" in contact and the callus about tongue showing clearly through the anterior and posterior windows in the cast.

SUMMARY

1. This adjunct is simple and inexpensive.
2. It constantly maintains the desired lengthening.
3. It saves the patient or the hospital the cost of four to six weeks of hospitalization.
4. It enables the patient to walk with, or without, crutches much sooner, for he cannot walk with the Abbott apparatus in place.
5. An active Orthopaedic Department needs fewer Abbott apparatus to take care of a definite number of cases in a given period of time as extra pins are all that are necessary.

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ABBOTT, L. C., CREGO, C. H., AND ADAMS, A. O.: The Operative Lengthening of the Lower Extremity. Internat. J. Orthodontia, XV, 110, Feb. 1929.

News Notes

Dr. Z. B. Adams has moved his office to 472 Commonwealth Avenue, Boston, Massachusetts.

Dr. Fremont A. Chandler has moved his office to 180 North Michigan Avenue, Chicago, Illinois.

Dr. Arthur Steindler, President-Elect of the American Orthopaedic Association, has recently been elected a Corresponding Member of the Belgium Orthopaedic Society.

The second Sir Robert Jones Lecture at the Hospital for Joint Diseases, New York City, was presented on October 13, 1931, by Dr. W. Edward Gallie, Professor of Surgery at the University of Toronto and President of the American Orthopaedic Association. His subject was "Further Advances in the Use of Living Sutures".

A lecture on "Sciatica and Backache from a Neurological Standpoint" was delivered at the Hospital for Joint Diseases, New York City, on December 16, by Dr. Walter E. Dandy of Johns Hopkins University.

It is with great regret that we announce the death of San.-Rat Dr. A. Schanz of Dresden on November 17, 1931. Prof. Schanz has held a prominent position among the orthopaedic surgeons of Germany, and his name has always stood in the advance guard in progress. He has added much to the development of his special department of surgery.

We regret to announce the death of Prof. Stanislav Tobiášek at Prague, on November 27, 1931, at the age of fifty-seven. Dr. Tobiášek was Professor of Orthopaedic Surgery at Caroline University and head of the Orthopaedic Clinic of the University, and was President of the Czecho-Slovakian Orthopaedic Society for the current year. In 1929, after many years of effort, he succeeded in establishing the University Orthopaedic Clinic at Prague. His death came at the full height of his energies and in the midst of a successful scientific and clinical work.

On the twenty-fourth of November, Prof. Henry Turner of Leningrad celebrated the fiftieth anniversary of the beginning of his active practice. Prof. Turner is a pioneer in his chosen specialty in Russia and is regarded as the "god-father" of Russian orthopaedic surgery, and is a Corresponding Member of the American Orthopaedic Association. He has given many valuable contributions to the literature of orthopaedic surgery in the Russian, German, and English languages, and has always held a prominent position among the medical profession in his country. His friends are congratulating him and are expressing their appreciation of his successful career.

The Clinical Orthopedic Society met at the University Hospitals, Iowa City, Iowa, on October 30. Interesting case demonstrations were given by Dr. Arthur Steindler, Dr. J. E. Milgram, Dr. J. Kulowski, and Dr. T. H. Vinke.

The following orthopaedic surgeons have established an informal group called **The Orthopaedic Association of Michigan:** Dr. C. E. Badgley, Dr. W. E. Blodgett, Dr. F. E. Curtis, Dr. R. V. Funston, Dr. A. G. Goetz, Dr. F. C. Kidner, Dr. A. D LaFerté, Dr. C. W. Peabody, Dr. F. H. Purcell, Dr. D. M. Stiefel of Detroit, Dr. V. L. Hart, University of Michigan, Ann Arbor, and Dr. J. T. Hodgen of Grand Rapids. This Association has made provision for Associate Members who must have had some training in orthopaedic surgery, but not necessarily devoting their full time to this specialty. Their function is to cooperate in the after-care of the State's cripples, but they are not yet allowed to carry out any operative procedures.

The principal object of the Association is to cooperate with the State Commission for Crippled Children in the care of indigent cripples from all parts of the State. The law gives the Commission power to hold clinics in the various counties in cooperation with local groups, such as the Rotarians and the State Crippled Children Society. The clinics are conducted by one of the State's recognized orthopaedic surgeons. As far as possible, the clinics are taken care of by the surgeons in rotation. The State law allows the local probate judges to send children who are examined at these clinics to anyone of the recognized hospitals for treatment. Recognition of the hospital depends on the equipment judged sufficient by the Commission. It is also necessary that they recognize that an orthopaedic surgeon should be a regular member of the staff.

Dr. Arthur Steindler, of Iowa City, was one of the lecturers at the Annual Fall Clinical Conference of the **Oklahoma City Clinical Society** held November 2 to 5. His subjects were: "Reconstruction of the Upper Extremity" and "Abscess Formation in Vertebral Disease; A Study of Differential Diagnosis".

The Extension Division of the **University of Oklahoma** furnishes annually a post-graduate medical program in which an orthopaedic post-graduate course is carried out on a circuit plan throughout the State. This plan brings to the practising physician authoritative information on orthopaedic subjects. The program presented this year in November and December included the following lecturers: Dr. C. B. Francisco, Kansas City, Mo.; Dr. F. J. Gaenslen, Milwaukee, Wis.; Dr. W. B. Carrell, Dallas, Tex.; Dr. J. S. Speed, Memphis, Tenn.; Dr. A. E. Bence, Wichita, Kan.; Dr. H. Winnett Orr, Lincoln, Neb.; and Dr. Frank Dickson, Kansas City, Mo.

A meeting of the **North Pacific Orthopaedic Society** was held on November 7 at the Vancouver Hotel, Vancouver, B. C. An interesting program was presented by the following:

Dr. Richard B. Dillehunt — Demonstration of unusual fractures and dislocations.
Dr. Richard F. Berg — Pneumo-arthrolysis.
Dr. Charles R. McClure — Injuries of the Carpus.
Dr. W. H. Goering — Osteochondroma of the Acetabulum.
Dr. Roger Anderson — A New Method of Treatment of Lower Extremity Fractures.
Dr. William E. Grieve — Treatment of Fractures of the Clavicle.
Dr. Harry Blair — Diseases of the Intervertebral Cartilages.
Hernia of the Nucleus Pulposus.
Dr. Alfred O. Adams — Application of Thiersch's Grafts.
Dr. H. J. Wyckoff — Os Calcis Fractures.
Dr. R. L. Jeffery — The Diagnosis of Arthritis.
Dr. John F. LeCocq — Klippel-Feil Syndrome.
An Unusual Congenital Deformity of the Spine.
Dr. Otis Akin — The Internal Fixation of Joint Fractures.

The following officers were elected for 1932:

President —	Dr. A. O. Adams, Spokane
Vice-president —	Dr. Richard Dillehunt, Portland
Secretary-treasurer —	Dr. William E. Grieve, Spokane

The Semi-annual Joint Meeting of the **San Francisco and Los Angeles Orthopaedic Clubs** was held in Los Angeles on November 7, under the leadership of Dr. H. D. Barnard, President of the Los Angeles Orthopaedic Society. The morning was devoted to interesting clinical demonstrations at the Orthopaedic Hospital by Dr. R. L.Carroll, Dr. Edwin F. Patton, Dr. Charles S. Young, Dr. Clifford A. Wright, Dr. Harold E. Crowe, Dr. Lowell S. Goin, Dr. A. Brockway, Dr. E. N. Reed, Dr. Howard Updegraff, and Dr. C. L. Lowman, and demonstrations in the underwater gymnasium by Miss Sue Roen. In the evening, following a dinner at the University Club, addresses were given by Dr. Morton R. Gibbons on "Industrial Accident Fees", Dr. Giles S. Porter on "California State Crippled Children's Act", and Dr. Junius B. Harris on "Medical Legislation and Economics".

At the Executive Committee Meeting of the **British Orthopaedic Association** held on November 30, the following were elected Full Members:

A. O. Parker, 80, Cathedral Road, Cardiff.
C. Gordon Irwin, 9, Sydenham Terrace, Newcastle.
Andrew Fowler, 9, Rubislaw Terrace, Aberdeen.
E. D. Telford, 169, Wilmslow Road, Withington, Manchester.
Pieter De Villiers Moll, 85, St. George Street, Capetown, South Africa.

The following were elected Associate Members:

Ralph Brooke, Warren Lodge, Western Place, Worthing, Sussex.
J. C. Drummond, Club of Western India, Poona, India.
John Taylor, 3, Somerville Place, Dundee.
S. G. Davidson, 53, Fountain Hall Road, Aberdeen.
H. J. Burrows, 6, Holly Lodge Gardens, London, N. 6.
N. L. Capener, Princess Elizabeth Hospital, Buckerell Bore, Exeter.

C. Thurston Holland, 43, Rodney Street, Liverpool, was elected an Honorary Member.

The Twenty-sixth Congress of the **Deutsche Orthopädische Gesellschaft** took place in Berlin on September 14, 15, and 16 under the presidency of Prof. Wollenberg. For the scientific portion of the Congress three main subjects were considered, all of which elicited a full and fruitful discussion. On Sunday, September 13, the President, according to custom, entertained the officers and invited guests at a luncheon.

On the first day, papers on the question of heredity were given by Dr. v. Verschuer of Berlin and Prof. Valentin of Hannover, — the former speaking on heredity and orthopaedic surgery, and the latter on constitution and heredity, emphasizing the importance of constitution as compared with heredity. A large number of members took part in the discussion and the emphasis was placed on the importance of the influence of heredity, dealing in particular with the special conditions met with in orthopaedic surgery.

The second forenoon was devoted to the consideration of spastic paralysis,— Dr. Hoffmann of Freiburg speaking on muscular tonus, and Dr. Stoffel of Mannheim on his particular field,— the resection of motor nerves. Dr. Stoffel made an exhaustive report of the work on this subject, including the method of selection and examination of cases for operation, the technique of operation, and the end results. There were also reports on more than 300 cases from the Berlin Orthopaedic Clinic. Following the afternoon session, the members and guests visited the Oscar Helene-Heim, founded by Prof. Biesalski and now in charge of Dr. Mommsen.

On the third day, the Congress considered the problem of operation on pronated flat-foot in children and young adults. The discussion was opened by Dr. Schrader of the Heidelberg Orthopaedic Clinic, who had collected opinions from a large number of orthopaedic surgeons and from the members of the Association. The very active discussion was directed mainly toward the consideration of the flexible foot and the stiff,

contracted foot, and it developed a wide diversity of opinion. A majority of the members present took part in this discussion. For the contracted, pronated flat-foot many diverse opinions in regard to treatment were offered, indicating that no one method of treatment is generally accepted, or is entirely satisfactory. Many were of the opinion that operations should not be performed except on sufficient indication of a definite impairment of function.

The remainder of the session was devoted to the presentation of papers on general subjects by the members of the Association, among which papers was an exceptional work by Dr. Böhm on the origin of the congenital dislocation of the hip.

Prof. Stoffel was elected President for the ensuing year and the next Congress will be held in Mannheim.

The Seventh Annual Congress of the **Czecho-Slovakian Orthopaedic Society** was held in Brno on September 27 and 28, with Prof. Dr. Bedřich Frejka as President. The first day was given to the inspection of the Institution of the National Society for the Care of Crippled Children at Brno, and of the hospitals and the clinics, with a demonstration of cases under treatment by the members of the staffs of the hospitals. The usual banquet was held in the evening. Dr. E. G. Brackett of Boston was the official delegate of the American Orthopaedic Association.

The second day was devoted to the presentation of papers. The principal subject for discussion was "Mineral Metabolism and its Relation to the Skeleton". Prof. Frejka, the President, presented the opinion that osteomalacia in adults is identical with rickets in children. His evidence for diagnosis in this condition is: the lowering of the level of calcium in the blood, which test, however, is not always positive; the elimination of calcium from the body, as seen by inspection of the teeth and x-ray study of the skeleton; proof that mineral metabolism is influenced by unsuitable food and by the lack of sunlight and fresh air; and proof of the therapeutic influence of alkaline foods, cod-liver oil and viosterol, and the effects of the mercury vapor lamp.

Prof. Bečka, of Brno, discussed the biological chemistry of calcium and phosphorus. The conditions for the physiological utilization of calcium in the body are: optimal reaction (pH 7.3 to 7.6), parathormon, vitamins, light, and the presence of active magnesium. The author assumes that phosphorus has similar conditions, as it is usually bound with calcium. Disturbances in the exchange of either element are of two kinds,— physiological and pathological. Disturbances caused by "calcium hunger" are tetany and osteoporosis; imperfect function in the exchange of calcium is shown in osteomalacia; the lack of phosphorus results in asthenia of the muscles; and rickets is evidence of a disturbance in the exchange of phosphorus. Therapeutically, the absorption of calcium salts is aided by adding magnesium to the food, especially in the form of hydroxid.

Prof. Laufberger, of Brno, gave the results of an exhaustive survey of mineral metabolism, which he demonstrated by tables and diagrams dealing with the topography of minerals, and with the movements in the digestive apparatus, and the mineral exchange as controlled by the nerves, hormones, vitamins, and ions.

Prof. Petřivalský, of Brno, spoke on the therapy of bone defects and stated it is first necessary to resort to operative treatment, applying iodin to the walls, and using some material to fill the spaces,— such as the Bečka paste which has an acid reaction, and helps to solidify its environment and to aid in dissociating the calcium and phosphorus in the bone. Second, in the constructive stage, crystals of the secondary and tertiary carbonates form during the time of slight alkaline reaction, and beam-work is gradually formed, which is aided by proper diet,— consisting chiefly of vegetables and a proper quantity of calcium chlorid.

Other speakers on the subject were Prof. Stoklasa, Prague; Prof. Zimák, Brno; Prof. Novák, Brno; Dr. Zelinka, Šumperk; Dr. Minář, Ljubliana; Dr. Uher, Brno; Dr. Přibyl; Dr. Felsenfeld. Dr. Rapant, of Brno, spoke particularly on the relation of calcium in conditions of acholic cachexia. Prof. Stoklasa spoke especially on radio-activity as an important biological factor with respect to old age. Prof. Bažant, of Brno, spoke

on the effect of mineral metabolism on the teeth and Prof. Novák gave a survey of the normal biological and biochemical processes during the healing of fractures. Dr. Zelinka spoke on the effect of the Hermannsdorfer diet in the treatment of bone tuberculosis and Dr. Minář discussed the importance of the use of inorganic salts in convulsions following orthopaedic operations.

The remainder of the session was occupied by the presentation of papers by Dr. Schulz, Dr. Mikula, Bratislava; Dr. Vidlička, Levice; Prof. Podlaha, Brno; Dr. Skřivánek, Brno; Dr. Jaroš, Prague; Dr. Polívka, Prague; Dr. Bedrna-Popek, Brno; Prof. Frejka, Brno.

Prof. Stanislav Tobiášek of Prague was elected President of the Society for the ensuing year.

The Annual General Meeting of the **British Orthopaedic Association** was held at Newcastle-on-Tyne on Friday and Saturday, October 30 and 31. The first morning was devoted to the reading of short papers, and in the afternoon cases were demonstrated at the Royal Victoria Infirmary.

Dr. Whateley Davidson, Newcastle, reported a case of osteochondritis ischiopubica in which there was limping and pain suggestive of early tuberculosis of the hip with tenderness and swelling over the ischiopubic ramus. X-rays showed a globular swollen appearance of the cartilaginous junction of the rami of the ischium and the pubis. The condition is rare and is thought to be traumatic in origin and analagous to osteochondritis of epiphyses. Symptoms subsided within a few months and the x-ray appearance became normal.

Mr. John Gilmour, Newcastle, reported the end results in a series of eighty-seven cases of tuberculosis of the hip. Conservative treatment in an abduction frame secured recovery of a limited range of movements in a large proportion of cases. A short fibrous ankylosis was a satisfactory end result, but recurring flexion-adduction deformity requiring repeated osteotomies was not infrequent. If the hip became unstable and dislocation or wandering acetabulum threatened, an extra-articular arthrodesis was advised.

In the discussion Mr. Naughton Dunn, Birmingham, stated that multiple osteotomies could be avoided if the child whose hip disease had become quiescent was left without apparatus for six months until maximum possible deformity had developed before the osteotomy was performed. Mr. McCrae Aitken, London, advocated non-weight-bearing, unloaded movement after the disease was quiescent, which encouraged recalcification of the femoral head and acetabulum and prevented flattening of the bearing surfaces. Mr. T. P. McMurray, Liverpool, strongly recommended conservative treatment, for the majority of adequately treated cases returned to work with a strong stable hip.

Mr. R. C. Elmslie, London, described seven cases of deposition of amorphous calcium in the supraspinatus tendon just above the great tuberosity. This should be differentiated from fracture of the tuberosity and from loose bodies in the joint. Very severe pain arose, and excision of the whole sac, including the adjacent part of the tendon, was advised. Symptoms were completely relieved and did not recur.

Mr. Ollerenshaw, Manchester, reported two similar cases. Mr. Watson Jones, Liverpool, said that the condition was exactly analagous to calcification of the semilunar cartilages, intervertebral discs, fibrosed lymph glands, and organizing blood clot, and was due to fibrosis. It occurred in other tendons, notably the tendo achillis after tenotomy. Occasionally the deposit could be aspirated subcutaneously with complete relief of symptoms.

Mr. Watson Jones demonstrated a simple portable apparatus by which anatomical reduction of overriding fractures of the shafts of the tibia and fibula could be secured, which allowed immediate fixation in plaster. Reduction was just as perfect as when an open operation was performed, and all the disadvantages of extension methods were avoided. The complete treatment of a case was illustrated by means of a cinematograph film.

Mr. S. A. S. Malkin, Nottingham, compared the relative merits of Albee's, Hey Groves', Gibson's and Hibbs' operations for fusing the spinous processes and laminae in tuberculosis of the spine. He was in favor of laying a double tibial graft on the laminae, one on either side of the bases of the spinous processes. Solid bony fusion could be demonstrated radiologically.

Mr. H. C. Edwards, London, opened a discussion on injuries of muscles and tendons and based his opening remarks on the paper for which he was awarded the Robert Jones Medal and Prize for 1931. He said that muscle strains should be treated by early exercise to avoid adhesions, and prevent wasting of the muscle as a whole. Massage was entirely useless. As a general rule ruptured muscles should be sutured in order to allow early exercise and movement. Late operations by fascial implantation where the retracted muscle belly had fully shortened were of no value. Pathological rupture of the long head of the biceps in chronic arthritis of the shoulder, "drummer's rupture" of the extensor pollicis longus, and spontaneous rupture of this tendon, following fractures of the lower end of the radius, were discussed. Other occupational muscle injuries were rupture of the tendo achillis in mountaineers, of the pectoralis major in boxers, of the external oblique in reapers, and the adductor longus in cavalrymen. Avulsion of the extensor tendon of the finger (mallet finger) was best treated by operation. Open wounds of the flexor tendons gave very poor results. Immediate operation in Hospital Casualty Department was strongly deprecated, not only because the operation was too difficult for any but a very experienced operator, but also because the risk of infection was much less after several days' interval. Bunnell's buried suture and immediate active movements with no immobilization were essential.

Mr. Rocyn Jones, London, had personally sustained a partial rupture of the calf muscles and had found raising the heel of the shoe to be of no value. Local strapping was beneficial. Mr. H. Platt, Manchester, said that the only reliable sign of complete rupture of the tendo achillis was an abnormal range of dorsiflexion at the ankle joint. Operative treatment was then necessary. Mallet finger should be treated conservatively by fixation for six weeks. Although the terminal joint required hyperextension, both of the other joints should be flexed. Mr. W. Trethowan, London, had observed the results of treatment by massage and exercises of a complete rupture of the tendo achillis in a professional dancer who had refused operation. The tendon united with half an inch of lengthening and, although the patient did subsequently dance, she was now much less efficient and had recently returned asking for operative treatment. Mr. Watson Jones said that myositis ossificans at the elbow and knee joints was purely traumatic and due to avulsion of a muscle insertion with periosteum. It was not an inevitable complication, and was curable by suturing the periosteum back to the bone. In cut finger tendons the suture of the profundus tendon alone was advised. This tendon provided ample power and, if the sublimis tendon was completely cut away, adhesion formation was minimized. Mr. Elmslie said that he had never seen a really satisfactory result when a flexor tendon of the finger had been cut below the distal palmar crease. Almost every speaker who had taken part in the discussion was in agreement and spoke in very strong terms of the danger of allowing Casualty Officers to suture cut tendons. The operation was never to be regarded as an emergency. Not only should several days elapse before it was undertaken, but the patient should be admitted to the wards, treated as a major case, and only operated upon by senior surgeons, preferably those accustomed to tendon surgery.

Current Literature

CLINICAL OBSERVATIONS ON THE SURGICAL PATHOLOGY OF BONE. By David M. Greig M.B., C.M., F.R.C.S. EDIN., F.R.S.E. Edinburgh and London, Oliver and Boyd 1931. 30 shillings.

The advantages of a varied hospital experience as surgeon to institutions where opportunity for the study of bone pathology has been abundant and access to the museum of the Royal College of Surgeons in Edinburgh where, for many years, the author has been conservator, are very apparent in the volume with the above title. The result has been the presentation of a refreshingly new conception of the changes that take place in bone as the result of injury and disease and a far more satisfying explanation of many of the clinical manifestations with which every surgeon having to deal with bone pathology has heretofore had offered to him. The old ideas of the methods of osseous growth have been obliged to give way in certain respects. No longer is the periosteum credited with the power to deposit bone as it used to be. The layer of cells in the periosteum formerly regarded as osteogenetic should properly be regarded as either fibrogenetic or osteogenetic and as such may be recognized at any period of life as a part of the phenomena of repair where bone is concerned, which is a wholly analagous process to that occurring in any connective tissue, which bone unquestionably is. In the present-day view the osteoblast is merely a fibroblast that has enlarged on account of its activity. These cells are subject to environmental influences and, to some extent at least, are under the control of hormones. The theory for a long time held that cartilage could be transformed into bone is untenable. Embryologically speaking, a mesenchyma cell may be differentiated into fibrous tissue, cartilage, or bone. Alteration in blood supply is a factor that plays a part in this process of differentiation and the influences that determine alterations in blood supply are derived from enzymes set free from certain cells rich in protein, a reflection of an orderly, and sometimes perhaps a disorderly, disturbance of the endocrine balance of the body. As a result of such biochemical changes a preosseous substance is laid down which is not hypothetical but demonstrable and long recognized as existing, but given no credit for playing any part in the process of bone building or repair. A second important property of the embryonic bone cell is halisteresis, the setting free of calcium. For all bone-building processes whether they are concerned with new bone formation, or pathological changes in disease, or the repair of osseous injuires, adequate blood supply and adequate calcium supply are essential. All cells, whatever their function or location, contain a substance called histamin, the liberation of which from the cell results in a physiological, local increase in the blood supply which induces hyperaemia and a transudation of blood serum. Pathological vasodilatation is produced in more profound injuries to tissue by a substance known as acetylcholin. When produced by the liberation of this substance vasodilatation is profound and prolonged. The general deduction he makes which constitutes the practical value of his observation and the observations of others is that: (1) if the circulation is maintained within certain limits bone remains normal; (2) if hyperaemia is produced bone undergoes rarefaction, decalcification, and osteoporosis; (3) if the blood supply is cut off bone undergoes necrosis. The bearing of these fundamental concepts of the behavior of bone under certain physiological and pathological conditions is then shown in such matters as the transplantation of bone, the production of foreign (osseous) bodies within joints, the osteoporosis following certain fractures (*e.g.*, Colles' fracture and intracapsular fractures at the hip joint), reflex joint atrophies, the alterations in skeletal architecture that are constantly taking place, infections in bone (in the periosteum, the marrow, and the cortex) the formation of sequestra and involucra, osteitis from septic arthritis, tuberculosis, syphilis (osteosclerosis), fibrositis ossificans progressiva, traumatic osteoma about joints, osteitis fibrosa, and the malignant tumors of bone,—*e.g.*, carcinoma (metastatic) and sarcoma.

One cannot read the latter portions of this volume, applying the principles defined in the first chapter, without feeling that a flood light has been thrown on the pathology of bone and that this pathology in no way differs essentially from pathology elsewhere, but has heretofore been looked upon as something apart. Certain aspects of the pathology of the chronic types of arthritis will be made more understandable from the application of the knowledge of the tissue reactions in osseous structures, brought about by distrubances in the vascular network in the neighborhood of articulations.

DIAGNOSIS IN JOINT DISEASE. By Nathaniel Allison, M.D., F.A.C.S., and Ralph K. Ghormley, M.D. New York, William Wood and Company, 1931. $9.00.

In the preface the authors urge a greater accuracy of diagnosis based on the knowledge of tissue change as well as of the etiological factors, and, in so doing, endorse the efforts of the many earnest workers in this subject in the attempts to discover the actual causes of this baffling disease. Unusual opportunities have been at their disposal to study the different phases of this subject in order to arrive at a satisfactory solution of this problem,—the facilities offered in the clinic of a large hospital, with the coordinated efforts of the members of the various departments,—such as the orthopaedic surgeon, medical clinician, biologist, chemist, and reontgenologist. In this investigation they have studied the subject with reference to: (1) the etiological factors; (2) the joint tissues primarily invaded or infected; and (3) the character of these tissue changes.

The work is presented in eight chapters: Introduction to the Physiology and Chemistry of Joint Structures; The Classification of Arthritis; the arthritides of known origin,—including Tuberculous Arthritis, Traumatic Arthritis, Arthritis Associated with "Loose Body" Formation, Pyogenic Infection of Joints; and those of uncertain origin, which are considered in two chapters, using the terms of Nichols and Richardson,—proliferative arthritis and degenerative arthritis.

A discussion of the classification of arthritis is always interesting and the chapter in this book is no exception. The classification, which almost might be called grouping, clearly indicates the method used by these authors, and is based on etiological factors and the primary tissue changes. This plan has directed their methods of study in this subject. The difficulty in completing a satisfactory classification today is shown by the term used by the authors to designate the group of arthritides of "uncertain origin" under which is placed those cases of undetermined origin, characterized by their peculiar clinical course and the pathological appearances, and which still refuse to fall into line. These are considered as comprising the group in which the etiological factors cannot be determined, and which, until further knowledge is available, must elude the attempts in any system of grouping to place them in a definite position. This chapter will be found interesting, for in it are also considered the pathological changes in the various structures of the joints as well as their methods of study for this classification.

In works of this kind on the general subject of arthritis, tuberculosis is not always considered, but, in this book, a generous portion is given to this subject, which is in accordance with the method of using etiological factors as a basis in addition to the clinical course of the disease, and each portion of the subject is fully and very carefully described.

To this discussion of each form of arthritis are added numerous illustrative case reports. The practitioner who is particularly concerned with the treatment of his patients and with prognosis, as well as end results, will regret that, since the clinical history of the onset, etc., is given, the outcome of the cases which are quoted throughout the work is not added. The work, however, is mainly confined to the consideration of the etiological and pathological factors with reference to diagnosis, but the end results would have made an excellent balance to the pathological and clinical data to this much studied disease, the definite information in regard to which is still elusive. It is by this continued study, however, that this disease will finally be placed among those which are now better understood and which are better treated. Under the terms of Nichols and Richardson the proliferative (atrophic) and degenerative (hypertrophic) types are placed

in the classification of "uncertain origin"; these cases are fully and carefully described and the pathogenetic and pathological findings clearly presented.

The authors quote freely from well known writers in the clinical description and in the theory of origins of these forms of arthritis, and finally summarize their own observations on these two types of joint manifestations. The specialist as well as the practitioner should devote considerable time to the study of this book.

The authors have presented this study in an attractive, almost an elaborate form, with copious illustrations including particularly well selected and clearly defined roentgenograms and nine colored plates. It is evident that they have spared no expense in the presentation of this work, on which they evidently have put a great deal of their time and thought.

ATLAS DE RADIOGRAPHIE OSSEUSE SQUELETTE PATHOLOGIQUE. I. LÉSIONS TRAUMATIQUES. By G. Haret, A. Dariaux, and Jean Quénu. II. LÉSIONS NON TRAUMATIQUES. By Étienne Sorrel and Mme. Y. Sorrel-Dejerine. Paris, Masson et Cie, 1931. 310 francs.

Four years ago these authors presented the "Atlas de Radiographie du Système Osseux Normal", giving the roentgenologic appearances of the normal skeleton and showing its development in different periods of growth from the new-born to the adult. This was intended to form a basis for comparison with the abnormal conditions, traumatic and pathological, which were to be considered in later volumes by the same authors. It has formed a most comprehensive presentation of this subject of normal anatomy, and has unusual illustrations of all parts of the skeleton with explanatory legends. This edition has been exhausted, but is now revised and republished. A second issue of this series has now appeared, and is of the same excellent and thorough presentation. It consists of two volumes: one dealing with the traumatic and one with the pathological (*lésions non traumatiques*); and, in the study of the material in these two volumes, the first book, on the normal bone, proves to be most interesting and important.

The first volume is devoted to the traumatic lesions. In the selection of the subjects for the illustrations, the authors have chosen types which have been recognized by the years of clinical and pathological observation, and have chosen those most frequently seen, as well as those which experience has proved to be most important. They have accompanied the photographs of fractures by diagrams, drawn personally by one of the authors, to characterize the type of lesion, with the object of presenting each with greater simplicity and clearness. All are shown as of the right side of the body, which is of advantage in the study of types rather than individual cases, and, as far as possible, the photographs are presented free from retouching of the negatives. In taking the x-rays of fractures, the authors insist on the necessity of views in different planes, because of the fact that many fractures are not visible in one plane alone, and illustrations are given demonstrating the truth of this statement.

In the volume on pathological lesions, as in the volume on traumatic lesions, the authors have chosen types to represent the various pathological conditions; they do not attempt to issue a complete atlas, but rather to give the more common and more important lesions, particularly to show the development of the progressive lesions,—as, for instance, the tuberculous. The authors have given tuberculosis a prominent place and generous space, which shows good judgment because of the importance of these lesions. They show not only the various types of these bone lesions, but also the progress in their development, as well as the end results of old cases of tuberculosis. The appearances of lesions in different stages of their development, with end results, are shown both in children and adults. This volume also considers lesions in arthritis, the neoplasms, and the dystrophies.

The wise selection of cases presented in these two books, following the many years of general accumulated clinical experience, will give the reader practically all of the varieties of lesions which will come to his notice. The individual varieties of the type are of less importance provided the principle of the type is fully demonstrated.

DIE NEUROPATHISCHEN KNOCKEN—UND GELENKAFFEKTIONEN (The Neuropathic Bone and Joint Lesions). By Prof. Dr. August Blencke and Dr. Bernhard Blencke. Stuttgart, Ferdinand Enke, 1931. 46 marks.

The work on neuropathic arthropathy which was begun by Dr. August Blencke in 1904 has now been completed as the eighth volume of *Deutsche Orthopädie*. This monograph is the third of the series to appear in the last ten years. It is divided into a general section covering the pathology and treatment of neuropathic skeletal lesions; a section with the discussion and voluminous case reports arranged topographically; and a third part which considers the relation of the subject to trauma in a medicolegal sense.

That a three-hundred-and-four-page discussion of so limited a subject is detailed goes without saying. The bibliography alone comprises twenty-five pages of fine type. Each point that is brought up in the text is elaborated to such an extent, with quotations from the literature and illustrative cases, that one longs at times for a friendly subheading in the blackness of the pages.

The arthropathies and pathological fractures of tabes naturally comprise the bulk of the material. Cases of general paralysis, hemiplegia, syringomyelia, transverse myelitis, and injury and malformation of the spinal cord are among those in which typical or bizarre skeletal changes are reported. The details of conservative and radical treatment are so well illustrated that less text and a few legends would have spared the reader much time. Because of its imposing solidity, few will read the paragraphs consecutively, but as a reference work it will endure as a worthy addition to our valuable orthopaedic monographs.

ACCIDENTAL INJURIES: THE MEDICO-LEGAL ASPECTS OF WORKMEN'S COMPENSATION AND PUBLIC LIABILITY. By Henry H. Kessler. Philadelphia, Lea & Febiger, 1931. 718 pages, $10.00.

The field covered by this text is the narrow and highly specialized one concerned with the compensability of workmen's injuries. Because of the nature of the subject its appeal to physicians will not be wide, but to those concerned in the subject, it should prove an invaluable fund of information. Perhaps it would be better if practising physicians engaged in the treatment of injured workmen were more familiar with the laws which govern their compensation and the multitude of intricate problems which beset their administration. To such practitioners this book also will be of interest since it deals extensively with problems in which they have at least a secondary interest.

After a brief historical review, Kessler discusses the fundamentals underlying all compensation laws. The laws of the various states in the United States and those of many other countries are used for illustration. There is a chapter devoted to discussion of "Schedules for Specific Injuries". Then follows, in thirteen chapters, the detailed discussion of every type of injury and occupational disease. Kessler's experience as medical advisor to the Workmen's Compensation Board of New Jersey has given him an unusual fund of information and this forms the basis of his book. It is of interest to Canadians to note that he regards as unique the Scoliosis Committee of the Province of Ontario. He devotes considerable space to a detailed description of its function.

This book should prove invaluable to executives of Workmen's Compensation Boards. It is full of interest to all engaged in public health work. The general practitioner and industrial surgeon will find in it much information concerning a great piece of social legislation, with other angles of which he comes into daily contact.

RADIOTHÉRAPIE: TECHNIQUE DU DOSAGE EN PROFONDEUR. By Charles Guilbert in collaboration with Dr. Jean Quivy. Paris, N. Maloine, 1932. 437 pp., 60 francs.

The authors state in their general introduction to the volume that there is but one radiotherapy, whether it be superficial or deep, and that the physics and the radiophysiology of the two are the same. They state that the selectivity of the various rays is problematical, and the dominant question is in regard to the absorption of the rays by

the tissues; throughout the work they have in mind the practical final factor of the application of the dosage to the various tissues of the body and for the different pathological conditions.

The book is divided into four parts. The first part is given over to the description of the physics and the discussion of the x-ray, the machines for its use and the laws of absorption. The second part is devoted to the general consideration of radiotherapy, its action on the tissues and organs and on the blood, the dosage, the mechanism of the action, the pathological action of irradiation, and the consideration of the application of x-rays of various strengths to the various pathological conditions. The third part treats of the general methods of irradiation, dealing particularly with the development and regulation of dosage, and carefully explains the meaning and significance of the terms "superficial and deep irradiation", and gives directions for the use of both. The fourth part is devoted to the explanation of methods for the application of the radiotherapy to various organs and parts of the body and to the different pathological appearances for which the irradiation is used. These are extensively considered and in detail.

The book shows care in preparation and presentation of this material and gives evidence of large experience in this subject. It is of value to the reader who has need of familiarizing himself with the physics and with the therapy of the x-ray, as well as to the specialist. The book contains a most complete bibliography.

SURGICAL PATHOLOGY OF THE DISEASES OF BONES. By Arthur E. Hertzler, M.D. Philadelphia, J. B. Lippincott Company, 1931.

The author has confined this work to the surgical pathology of bone and presented this under two heads: Diseases of Bone, and Tumors of Bone. The term "surgical pathology" is evidently employed to designate the various forms which may be placed in this one group and presents a particular aspect to the active surgeon. Under the head of Diseases of Bone are considered the acute and chronic inflammations and the results of the specific infections and those of unknown origin,—such as Köhler's disease, etc. The pathogenesis, as well as the pathology, is discussed in detail and the scope of the work is most comprehensive. This is supplemented by very numerous and excellent illustrations; particularly are the x-rays of the acute and chronic inflammations of bone of value, demonstrating the various forms and the bone changes of osteomyelitis.

The author devotes a chapter in the second part to the classification and accepts that of the Registry Committee, which is given in detail. As in the first portion, the important forms are all considered. He has also added to the value and interest of the book by describing not only the more important and interesting subjects in these two groups, but also by considering with care the common and less serious and less important infections,—minor developments of bone diseases and growths.

The book is somewhat unusual in its complete scope. Taking as it does the subject of surgical pathology, it will be found most helpful to the practical surgeon.

SCHOOL ORTHOPAEDICS. A GUIDE FOR TEACHERS. Compiled for The Devizes Orthopaedic Clinic by Miss L. S. Rolleston and Lieut.-Col. W. K. Steele, R.A.M.C., Springfield, Devizes, England, 1931. 2 shillings.

A small pamphlet of twenty-five pages designed to guide the physiotherapist in the principles and the practice of gymnastics for children of school age, especially for the improvement of posture and the amount as well as the kind of exercise. It will be found of value for such a purpose. The title is not well chosen. The term "orthopaedics" is always regrettable, and, in this case, does not sufficiently indicate the material in this pamphlet which is in the field of physiotherapy.

The Journal wishes to acknowledge the receipt of the following publications sent to the Editorial Department:

*Tratamento Cirurgico da Tuberculose Ossea. By Barros Lima. Recife, Imprensa Industrial, 1931.

*To be reviewed in a later issue of *The Journal*.

*Die Pseudarthrosen (Nebst Wahrscheinlichen Vorstadien) Nach Medialen Frakturen des Collum Femoris und Deren Behandlung. By H. Camitz. Acta Chirurgica Scandinavica, Vol. LXVIII, Supplementum XIX. Stockholm, 1931.

Röntgendiagnostik der Erkrankungen der Inneren Organe. By Emmerich Markovits. Leipzig, Georg Thieme, 1931.

*Untersuchungen über das Wirbelgleiten. By Hermann Meyer-Burgdorff. Leipzig, Georg Thieme, 1931.

Eine Studie des Nierentuberkulosematerials aus der Lunder Chirurgischen Klinik der Jahre 1901 bis Einschl. 1923. By Robert Ivarsson. Acta Chirurgica Scandinavica, Vol. LXVIII, Supplementum XVIII. Stockholm, 1931.

Slovanský Sborník Ortopedický. Brno, Czecho-Slovakia, Vol. VI, Nos. 4 and 5, 1931.

Chirurgia Clinica Polonica. Kraków, Vol. II, Fasc. 1, 1931.

Annaes Paulistas de Medicina e Cirurgia. S. Paulo, Brazil, Vol. XXII, Nos. 9, 11, and 12, September, November, and December, 1931.

Bullettino e Atti della Reale Accademia Medica di Roma. Rome, Vol. LVII, Fasc. 11, November 1931.

Anales del Servicio de Traumatología y Cirugía Ortopédica del Hospital Provincial. Valencia, 1930.

Ortopedia e Traumatologia dell' Apparato Motore. Rome, Vol. III, Fasc. 4, August 1931.

Norsk Magasin for Laegevidenskapen. Oslo, Vol. XCII, Nos. 6, 7, 8, 9, and 10, June, July, August, September, and October, 1931.

Om Steriliteten hos Kvinner, dens Årsaker og Behandling. By Harald Natvig. Tilleggshefte til Norsk Magasin for Laegevidenskapen. Oslo, Vol. XCII, No. 8, August 1931.

Årsberetning for Vestfold Fylkesykehus 1930. By Nikolai Paus. Bilag til Norsk Magasin for Laegevidenskapen, Vol. XCII, No. 10, October 1931.

Columbia University, New York Post-Graduate Medical School, Announcement of Courses 1931–1932. New York, 1931.

*Lehrbuch der Röntgendiagnostik. By H. R. Schinz, W. Baensch and E. Friedl. Ed. 3. 2 Vols. Leipzig, Georg Thieme, 1932.

*To be reviewed in a later issue of *The Journal*.

ON THE RELATIONSHIP BETWEEN THE PARATHYROID HORMONE AND THE GROWTH OF RAT CARCINOMA. T. S. Paik. *Am. J. Cancer*, XV, 2756, Oct. 1931.

The author injected several series of rats with parathyroid hormone after implantation of the Flexner-Jobling rat carcinoma. The rate of growth of the transplanted tumors was compared with that in a control group. He investigated similarly the effects of parathyroidectomy, parathyroid transplantation, and the injection of calcium chlorid solution. He concluded that the internal secretion of the parathyroid gland stimulates the development of rat carcinoma, but decrease of its internal secretion interferes with development of such a carcinoma. Calcium chlorid injections did not stimulate tumor growth.

(These experiments seem to be of interest because of the increasing recognition of the rôle of the parathyroid hormone in calcium metabolism.)—*Grantley W. Taylor, M.D., Boston, Mass.*

EDITORIAL: BIOPSY IN THE DIAGNOSIS OF TUMORS. *Am. J. Cancer*, XV, 2798, Oct. 1931.

In the course of discussing the uses and abuses of biopsy in general, Wood writes as follows in regard to bone conditions:

"Tumors of the bone offer a puzzling situation. There are many surgeons and radiologists who are opposed to biopsy. Nevertheless, if the diagnosis of a giant-cell tumor were made more frequently by biopsy procedure, many limbs would be saved

from amputation. On the other hand, is it wise to ray a bone tumor without knowing its nature? Many radiologists recommend that a supposed osteogenic sarcoma be rayed without a biopsy specimen. Here again the records are not quite clear, for the diagnosis of bone tumors is still far from perfect, both from the radiologic and histologic aspect, and while it would certainly seem that a mutilating operation should not be performed without a microscopic diagnosis to show its justification, neither should a patient be subjected to merely palliative radiation when the tumor might prove to be a type for which operation would be effective. Only a great deal more experience than we now possess will decide these questions."—*Grantley W. Taylor, M.D., Boston, Mass.*

THE OSSEOUS LESIONS OF CONGENITAL SYPHILIS. Summary and Conclusion in 102 Cases. Stafford McLean. *Am. J. Diseases of Children*, XLI, 1411, June 1931.

Seventy-one per cent. of the cases were in the first three months of life; eighteen and six-tenths per cent. in the second three months of life; ninety per cent. were not over six months of age.

The first three months is the age of election of all varieties of lesions. The first six months is the age of election for osteochondritis. The lesions that occur during the balance of the year are largely of the residual variety,—*i.e.*, periosteal cloaking, changes in trabeculation and the like. With advancing age, beginning at the sixth month, it is difficult to diagnose syphilis on roentgen evidence without collateral help. After the first and up to the fourth year of life, congenital syphilitic bone lesions are probably largely due to relapse of an incompletely healed lesion of early life. They are generally manifested as subperiosteal overgrowth, which looks like osteomyelitis. Favorite sites are the metacarpal bones and the phalanges, but other long or flat bones may be involved. It is doubtful whether the reparative splinting by abnormal production of subperiosteal bone in congenital syphilis differs greatly from that produced in any other type of disease which involves bone.

Syphilitic lesions are always distributed bilaterally, and in the first few months of life a lesion of a single bone, in our experience, has never been due to syphilis. Lesions of tarsals, metatarsals, metacarpals and phalanges do not occur in the first few months of life. Subperiosteal multilayered cloaking, the most spectacular roentgen observation, may be present on the most predominating lesion after the fourth month, and as the sole active lesion after the fifth month of life. At this age and up to the early part of the second year, it is of great diagnostic importance.

The author concludes that an unequivocal diagnosis of osseous syphilis can be made from the roentgenogram alone in certain types of lesions, and also that, in the preponderance of the cases, the roentgenogram divulged more information than the microscopic section.—*T. H. Vinke, M.D., Iowa City, Iowa.*

FRACTURE OF EXTERNAL SESAMOID BONE AT THE FIRST METATARSO-PHALANGEAL JOINT. Marcus H. Hobart. *Am. J. Surg.*, XIII, 242, Aug. 1931.

The author reports a case of a colored male who entered the Evanston Hospital Clinic, February 28, 1930, because of a left foot injured when a wheelbarrow full of planks turned over, striking him on the top of the foot forcibly. The history and physical findings were typical for fractured sesamoid bone. X-rays showed an oblique division. Bone was removed, which gave ample opportunity to confirm the diagnosis through pathological laboratory.

Patient was operated upon April 3, 1930, cast was removed April 28, 1930, and patient went back to work cured, May 5, 1930.—*T. L. Waring, M.D., Iowa City, Iowa.*

CA-GEHALT DES BLUTES UND CHRONISCHER GELENK-RHEUMATISMUS (The Calcium Contents of the Blood in Chronic Articular Rheumatism). M. Bastos und L. Mazo. *Arch. f. Klin. Chir.*, CLXI, 222, 1930.

The material investigated is as follows: twelve cases of ankylosing polyarthritis; ten cases in monarticular arthritis deformans; three cases with progressing, non-ankylosing arthritis deformans; and eight cases with rheumatoid or postinfectious secondary

arthritis. The examination of the cases of monarticular arthritis shows that increase of the calcium value stands in relation to the degree of bony destruction and new bone formation in the joint. The highest values were thirteen and eighty-six hundredths; this case was an arthritis deformans with excessive deformations, a marginal exostosis and free joint bodies. In rheumatoid arthritis without extensive bony lesions, the values were normal. In the ankylosing type of arthritis there were also found increased values of the calcium contents. The authors ascribe to the mobilization of the organic calcium the changes occurring in the ankylosing type as well as in the monarticular arthritis deformans. The authors further have found a slight diminution in the calcium contents in cases of tuberculous arthritis. There were, in two cases, extensive cyst formations of the bone, and the calcium values were also considerably increased, more than thirteen milligrams per 100 cubic centimeters of blood. The authors refer to the observation of Bach regarding the changes of the calcium contents in the blood during the period of repair of bone fractures. This author found that the calcium content of the blood in the first eighteen to twenty-two days increases over the normal at the ratio of ten to eight. Segovia, who investigated the calcium mobilization after fractures, comes to the conclusion that the calcium necessary for consolidation is derived from the region of the fractures themselves; an opinion which is also shared by Leriche and Policard. The bone is a storeroom of the calcium necessary for repair, comparable to the storage of the glycogen in the liver. Calcium can be mobilized without the necessity of any changes in the calcium quantities induced by food, which shows stability of the calcium equilibrium under normal conditions.

In conclusion, the authors maintain that the calcium values are constant in the normal, as well as in cases with articular rheumatism, but that, parallel with the bony changes in the skeleton, elevations of the calcium balance occur, which the authors consider not as the cause but the effect of the morbid process.—*A. Steindler, M.D., Iowa City, Iowa.*

Das Halsrippensyndrom und Seine Chirurgische Behandlung (The Cervical Rib Syndrome and Its Surgical Treatment). H. Jacobsohn. *Arch. f. Klin. Chir.*, CLXI, 398, 1930.

The author gives a very thorough review of the entire literature on cervical rib. He points out that one may speak of a cervical rib syndrome without cervical rib, and that satisfactory therapeutic results were not obtained until one was ready to operate, even without positive x-ray findings; a viewpoint which was substantiated by Sargent in 1913 in a report on thirty-four cervical rib operations. Sargent found, in cases of hypertrophic transverse processes, a fibrous band uniting these with the first rib. He noted that the band became tight in inspiration and caused pressure upon the plexus. Such a band from the transverse processes of the seventh cervical to the first rib was also found by Law, and in some cases the transverse processes appeared entirely normal.

A very substantial simplification of the surgical treatment of the cervical rib syndrome was brought about by the publications of Adson and Coffey in 1926, they having observed that plexus and subclavian artery were compressed between cervical rib or its ligamentous extension and the anterior scalenus muscle. With eight successful operations in the literature, the author believes that the operation is fully justified if undertaken before the irreparable changes of nerves and vessels have appeared. This operation may also be carried out as a preliminary operation and be followed by the removal of the cervical rib in case the clinical symptoms do not fully subside.—*A. Steindler, M.D., Iowa City, Iowa.*

Seltene Ursache einer Mauseinklemmung im Kniegelenk, ein Beitrag zur Klinik der Xanthomatösen Riesenzellgranulome (Unusual Cause of Joint Body Impingement in the Knee Joint. Xanthomatous Giant Cell Granuloma). W. Latten. *Arch. f. Klin. Chir.*, CLXI, 416, 1930.

The offending formation was a tumor in the knee joint, the size of a prune, of yellowish-brown color, soft consistency, starting from the meniscus or from the neighboring portions of the joint capsule. The tumor proved to be a xanthomatous giant-cell

granuloma. Such cases of xanthomatous giant-cell granulomata in joints, which produce typical impingement symptoms, have been described in the literature repeatedly, and the author quotes a number of references to the literature. A blood examination of the patient shows 220 milligrams of cholesterin,—that is, a marked hypercholesterinaemia, and the author believes that this considerable increase of cholesterin in the blood forms the basis for accumulation of lipoid xanthomata in the granulomatous structures.—*A. Steindler, M.D., Iowa City, Iowa.*

Über Beziehungen der Knochenbruchheilung zu Chemischen Veränderungen im Blute und ihre Beeinflussung durch Calcium-Vitamin-Behandlung (Healing of Fractures in Their Relation to Chemical Changes in the Blood and Their Reaction to Calcium Vitamin Treatment). L. Pincussen und B. Neuman. *Arch. f. Klin. Chir.*, CLXV, 483, 1931.

In experiments on rabbits and in the large majority of clinical investigations, it was shown that in fractures there is a marked shifting of actions in the blood. This in animals affects mostly potassium; in man, magnesium. After administration of a calcium-vitamin preparation (pro ossa), these fluctuations are definitely decreased and the curves showing the relationship to each other are noticeably more regular. The clearly demonstrable improvement by treatment in animals and acceleration of callus formation seem to be present also in man.—*R. J. Dittrich, M.D., Wichita, Kansas.*

The Union of Grafts of Live and of Preserved Fascia with Muscle. S. L. Haas *Arch. Surg.*, XXIII, 571, 1931.

Seven experiments were performed in which a piece of fascia lata that had been preserved in alcohol was transplanted in place of a piece of hamstring tendon and muscle removed from a dog. Examination at various periods, following the operation in the different animals, showed that union was almost secure after twenty-two days and with the lapse of further time the union was complete. Microscopic examination showed that the endomysium and perimysium played the major rôle in the union. There was no evidence of foreign-body reaction or absorption. Grossly the transformed tissue did not tend to make a firm, tendinous structure, but in general was somewhat gelatinous (oedematous). In this respect it differed from live fascia used as the graft, in that the live fascia was more tendinous and retained more of its elasticity. Microscopically there was no apparent difference.

The author concludes that, "Dead, preserved fascia may be used clinically for union with a muscle, but it seems advisable to utilize the live fascia if possible, because the latter appears to be transformed into tendinous tissue more readily."—*Marcus Schwartz, M.D., Baltimore, Md.*

Skeletal Metastasis Arising from Carcinoma and from Sarcoma. Murray M. Copeland. *Arch. Surg.*, XXIII, 581, Oct. 1931.

This article constitutes a comprehensive and exhaustive study of 334 cases of skeletal metastasis from malignant neoplasms. The material was obtained from the Department of Surgery and the Surgical Pathological Laboratory of the Johns Hopkins Hospital and University. The important clinical features, the x-ray appearance, the incidence of metastasis of the various types, the incidence of involvement of the various bones and the histogenesis are set forth. From this data an attempt is made to draw some conclusions as to the mode of metastasis and to determine the most satisfactory method of treatment.

A list is given of the parts involved by the metastases in cases of breast carcinoma, hypernephroma, and primary malignancies of various organs.

The methods of metastasis as suggested by a study of these cases are discussed. In general, both an embolic (hematogenous) and a lymphatic mode of involvement are responsible for metastatic lesions of the bone. The particular circumstances of each case, such as the duration and the character of the primary tumor, together with the method of treatment, will often determine the mode of metastasis.—*Marcus Schwartz, M.D., Baltimore, Md.*

INTRACAPSULAR FRACTURES OF THE NECK OF THE FEMUR. TREATMENT BY INTERNAL FIXATION. M. N. Smith-Petersen, Edwin F. Cave, and George W. VanGorder. *Arch. Surg.*, XXIII, 715, Nov. 1931.

The functional impairment resulting from immobilization has proven to be a major handicap to the treatment of fractures of the neck of the femur by methods of external fixation. Internal fixation has proven unsatisfactory because: first, the usual round or square nail fails to hold the fragments in position, and, second because the bulk of the nail destroys considerable bony tissue and causes localized necrosis.

To combat these difficulties the authors have developed a flanged nail which reduces the tissue damage to a minimum and at the same time locks the fragments securely. The operative technique for the use of the nail and the instruments necessary for this operation are clearly described. The exposure of the fragments is accomplished by a modification of the Smith-Petersen hip approach. The authors stress the point that accurate reduction of the fracture, correct placement of the nail, and close impaction of the fragments are necessary for success. Complete case reports of the first twenty-four patients treated by this method are given. Eighteen of these patients were over fifty years of age. The operative shock was not great, so that no immediate postoperative deaths ensued. Two patients died from sepsis. Seventy-five per cent. of the cases gave good bony union; fifteen per cent. non-union.

It is pointed out that this procedure did not necessitate plaster-of-Paris immobilization after the operation, and that early functional restoration took place. The technique was useful for old non-unions as well as for recent fractures.

The article is well written, well illustrated, and quite convincing.—*I. William Nachlas, M.D., Baltimore, Md.*

ZUR ÄTIOLOGIE UND THERAPIE DER ISCHÄMISCHEN LÄHMUNG DES VORDERARMES (Etiology and Therapy of Ischaemic Paralysis of the Forearm). Wilhelm Bittner. *Bruns Beitr. z. Klin. Chir.*, CLII, 510, 1931.

Of the four cases here reported, three were observed among 2850 cases of fracture of the upper arm and forearm. Etiologically, in addition to a certain predisposition, a hematoma is a decisive factor. The latter, by compression of the vessels and nerves, produces an ischaemia and later, by fibrous degeneration of the muscles, leads to scar formation and thus injures the nerves.

The treatment in the earliest stages should consist of removing the hematoma by puncture or incision. After the contracture has developed, the most successful results are obtained by early neurolysis. Of the four cases, one was treated by resection of the radius and ulna, one by neurolysis of the median nerve, and two by neurolysis of the ulnar nerve and lengthening of the flexor tendons.—*R. J. Dittrich, M.D., Wichita, Kansas.*

FEMORAL CONDYLITIS. Merrill Coleman Mensor. *California and Western Med.*, XXXV, 121, Aug. 1931.

The author discusses two cases presenting symptoms of inflammation over a small area two centimeters above the joint line on the external condyle of the right femur. The x-ray revealed in each case a small calcified spot apparently separated from the inflamed area. There was no history of trauma in either case, the pain appearing suddenly, accompanied by oedema, local heat, fever and leucocytosis. One case was operated upon, but no pus or fluid was found; the culture demonstrated the staphylococcus albus. The other case was treated by continuous heat and recovered as quickly as the first. The author believes this to be a definite selective osteomyelitis of low virulence which may readily be mistaken for injury in industrial practice.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

THE PHYSIOLOGY OF THE PARATHYROID GLANDS. J. B. Collip. *Canadian Med. Assn. J.*, XXIV, 646, May 1931.

This is a report of the more recent developments in this field.

The function of the parathyroid gland is apparently the maintenance of a definite level of total calcium in the plasma. Hunter has demonstrated a specific effect of the parathyroid hormone on the activity of the osteoclasts of the bone. It has been shown

that increase in the blood serum calcium following injection of parathyroid hormone is due to the mobilization of this element from the bone reservoirs.

The biochemistry of calcium is considered.

In discussing the absorption of calcium, he points out that it is probably absorbed in the ionized form. It has been shown that vitamin D influences directly the absorptive process for calcium. The fecal calcium represents both the unabsorbed calcium of the food and re-excreted calcium. It is excreted by the kidney in amounts of from one-tenth to five-tenths grams per day on a normal diet.

The relation of inorganic phosphorus to calcium is discussed. The preparation of the internal secretion of the parathyroid gland is presented. The physiological effect of the hormone is that of a mobilizer of the blood plasma calcium. The source of this additional calcium in the blood stream is bone. The effect of the progressive changes in blood chemistry during parathyroid hormone overdosage has been studied. The active extract is specific for the treatment of parathyroid tetany.

Aub has shown that humans, when treated over a prolonged period with the hormone, develop a condition of immunity to the specific calcium-mobilizing effect. Calcium metabolism is also affected by diet, acidosis, alkalosis, exophthalmic goiter, and vitamin D. These are considered.

He next gives clinical conditions in which calcium metabolism or parathyroid function is disturbed.—*M. E. Pusitz, M.D., Iowa City, Iowa.*

Avulsion of the Lesser Trochanter of the Femur. J. S. McEachern and H. N. Jennings. *Canadian Med. Assn. J.*, XXV, 449,Oct, 1931.

Gives details of a case of the injury in a boy of fourteen. Patient was put to bed with the right leg suspended in a bent Thomas frame. After five weeks he was allowed up with crutches. Six weeks later the boy complained of no discomfort.

Avulsion of the lesser trochanter of the femur is a rare injury. Metcalfe collected eleven cases from the literature and added two of his own. Treatment by fixation of the hip in flexion has given good results in nearly all cases. One youth developed an infected hematoma and died from tetanus. In another case operative fixation of the lesion was done and that patient also died.—*A. Gibson, M.D., Winnipeg, Canada.*

Traumatic Aneurysm of the Subclavian Artery as a Late Complication of Fractured Clavicle. E. H. Cayford and F. J. Tees. *Canadian Med. Assn. J.*, XXV, 450, Oct. 1931.

Fractured clavicle is very rarely followed by any sequelae of importance. When the artery is injured, the sequence of events according to Keen is as follows: Injury of the vessel wall allows leakage into the wall; a thrombus then follows, is organized into scar tissue, which is unable to withstand the pressure of the blood, and stretches, forming a false aneurysm.

Case report is given of an aneurysm of the subclavian artery, following a football injury, operated upon twice—in the second operation by ligature of the artery—with recovery. When last seen, about four months after the operation, there was no evidence of motor or sensory disturbance and patient enjoyed full use of the arm.

It is better to ligate both artery and vein than artery alone. The operation emphasized the difficulty of intrasaccular repair of aneurysm. There may be leakage due to dissection of arterial blood through the faulty repair of low-grade tissue, or there may be dilatation at the suture line. With the experience of this case and the help of the available literature, it would seem safer to adopt a less conservative procedure and to tie the vessel proximal to the aneurysm in the first instance. The present case is convincing evidence that the corresponding vein should be tied as well, and that the ligature should be above the arterial one.

KLINISCHER UND EXPERIMENTELLER BEITRAG ZUR PERITENDINITIS CREPITANS (Clinical and Experimental Contribution to Peritendinitis Crepitans). Paul Moritsch und Alice Blau. *Deutsch. Zeitschr. f. Chir.*, CCXXXI, 550, 1931.

Peritendinitis crepitans was found in one and thirty-nine hundredths per cent. of 16,900 cases. Brief clinical records of twenty-six patients are reported. In twenty-two cases the condition was found in the forearm and hand, in four cases in the lower extremity. The extensors of the wrist and fingers were affected in twenty-one cases. The affection is more common during cold weather.

Etiologically, the most important factor is a combination of infection of the nose or throat and trauma (overexertion). The clinical features are pain, swelling, and crepitation, involving one or more tendons. Therapy consists of immobilization of the affected part, and treatment of the acute infections. The average duration is two to three weeks.

The authors succeeded in producing the clinical picture experimentally in rabbits. In addition to fatiguing of the muscle by electrical stimulation, it was necessary to produce a toxaemia by injection of typhoid vaccine or bacteria.—*R. J. Dittrich, M.D., Wichita, Kansas.*

DER ABLAUF DES MINERALSTOFFWECHSELS UND DESSEN BEZIEHUNGEN ZUR INNEREN SEKRETION BEI KNOCHENBRÜCHEN (Metabolism of Minerals and Its Relation to Internal Secretion in Fractures). Hans Stocker. *Deutsch. Zeitschr. f. Chir.*, CCXXXI, 714, 1931.

By investigations and observations in fractures with normal and delayed union, an experimental and clinical study was made of the metabolism of minerals and its dependence on the activity of the endocrine glands. In addition, investigations were made on the influence of calcium pho phorus or thymus therapy on the healing of fractures.

By microchemical methods, determinations were made of the inorganic calcium and phosphorus of the blood and the urine, and it was demonstrated that in fractures with normal union, a hypercalcaemia is produced, which persists until the osteoid callus has been changed to bone tissue. No change was noted in the phosphorus content.

With delayed union similar changes were found in the blood; however, the hypercalcaemia persisted for a longer period and a more pronounced excretion of calcium was found in the urine.

The statement of Peterson that the product of calcium and phosphorus was less than thirty in case of delayed union, could not be confirmed. As the actual cause of delayed callus formation, the disturbance is not one of metabolism, but rather is at the site of the fracture. The nature of the disturbance is not definitely known, but probably consists of injury to the blood vessels, which would prevent an adequate supply of calcium.

Experimentally the influence of therapeutic measures on fractures was studied in young, non-thymectomized dogs. A hastening of the consolidation process could not be produced either by administration of calcium and phosphorus, or by injection of thymus preparation.

In patients who had no other disease, and in whom delay of union was noted, administration of thymus produced an enormous shifting of the inorganic elements of the blood and urine, consisting of an increased mobilization and retention of short duration. Calcium phosphate could not be deposited at the site of the fracture, due apparently to poor circulation, and as a result there was an increased excretion of calcium and phosphorus. Practically, the results were negative also following thymus administration.

In general, calcium and phosphorus metabolism is dependent on the function of the glands of internal secretion, since apparently by the regulatory activity of the epithelial bodies system, sufficient amounts of mineral salts are absorbed and placed at the disposal of the cell, whereas the thymus affects the chemistry and, by checking the formation of acids (nuclein-phosphoric acid), provides for the presence of calcium-destroying agents (alkalies). With a hyperacidity of the organism a lack of calcium is brought about by increased excretion of calcium and phosphorus.

The action of thymus extract depends on an increased function of the thymus gland, which results in a reduction of the acids in the organism. This condition produces, accordingly, an increased mobilization of calcium and phosphorus in the tissues. The influences of other endocrine organs on mineral metabolism must be considered, but are completely unexplained.

The analysis and findings of mineral metabolism in cases of delayed union demonstrated clearly that, therapeutically, the only available measures are those directed toward the seat of the disturbance, the site of the fracture, since calcium deposition can result only from alteration of unfavorable conditions at that point.—*R. J. Dittrich, M.D., Wichita, Kansas.*

ZUR ARTHRODESENFRAGE (Problem of Arthrodesi). Fritz Lange. *Deutsch. Zeitschr. f. Chir.*, CCXXXII, 4, 1931.

Arthrodesis of the elbow, hip, and knee joints is rejected. In the wrist joint it is indicated in the absence of any other substitute for the paralyzed muscles. In the shoulder joint it yields excellent results in cases of deltoid paralysis. The extensively used and indiscriminate ankylosis of four to eight joints in the foot is condemned. The author recommends limiting the operative procedure to the joint which produces the flail foot. In the ankle joint passive mobility of five to ten degrees should be obtained; in the subastragaloid joint the aim should be complete ankylosis.—*R. J. Dittrich, M.D., Wichita, Kansas.*

ERFAHRUNGEN ÜBER DIE RADIKALOPERATION DER ANGEBORENEN HÜFTVERRENKUNG BEI ERWACHSENEN (Experiences with Open Operation in Congenital Dislocation of the Hip in Adults). Carl Deutschländer. *Deutsch. Zeitschr. f. Chir.*, CCXXXII, 52, 1931.

The author makes an analysis of twenty-three cases of congenital dislocation of the hip in adults subjected to operation. Of these, nineteen were end results. The ages varied from eighteen to sixty-five years. The procedure is very satisfactory and not attended with danger. Emphasis is placed on the importance of overcoming obstacles to correction by means of the scalpel, rather than blind force.

A two-stage operation is employed. The preliminary operation consists of overcoming muscular resistance by tenotomies of the adductors biceps femoris and rectus femoris, and application of skeletal traction. This is followed in ten to fourteen days by the main operation.

Of the nineteen cases, one died and two resulted in ankylosis. Two-thirds of the cases resulted in complete or satisfactory reposition and about one-fourth showed a transposition.

In contrast to the anatomical results, the functional results—based on elimination of pain, shortening, and lordosis, and restoration of a stable gait—were more favorable. Restoration of joint mobility was excellent in eleven cases and satisfactory in six cases. The greatest range of motion was found, contrary to expectations, in the cases of eccentric repositions and transpositions, rather than in those of concentric reductions.—*R. J. Dittrich, M.D., Wichita, Kansas.*

CALCIFIED DEPOSITS IN SUBDELTOID BURSITIS. E. B. Mumford and Florence J. Martin. *J. Am. Med. Assn.*, XCVII, 690, Sept. 5, 1931.

The authors here discuss only that phase of subdeltoid bursitis in which calcareous deposits were present.

A brief review of the anatomy and symptoms is given and the following conclusions made after a study of fourteen of their own cases:

1. The etiology is indefinite, but repeated mild traumata with the arm abducted may be an important factor, or a single mild or severe trauma leading to an injury of

the tendons in this region may be a contributory cause. Why a calcium salt should be deposited in some cases, or in this particular bursa, and not in others is not known.

2. The calcareous deposit has no relation to the pain, other than it may possibly lead to further trauma, producing an acute attack; however, it may remain after the symptoms have disappeared.

3. If the deposit is a calcium salt it reacts unlike any other calcium deposit,—it may form without an apparent cause; it is often fragmented; and it will disappear under the influence of diathermy.

4. Conservative treatment in the form of diathermy treatment should be instituted and surgical intervention should never be advised.—*Ruth Jackson, M.D., Dallas, Texas.*

Surgical Treatment of Chronic Arthritis. Henry W. Meyerding. *J. Am. Med. Assn.*, XCVII, 751, Sept. 12, 1931.

An interesting treatise on the surgical possibilities in the treatment of chronic arthritis, with a report of seven cases treated by the author, the results of which were gratifying and offer encouragement in the treatment of deformities associated with chronic arthritis.

The advantages of measures to prevent contractures in the early stages of arthritis are discussed: synovectomy, capsuloplasty, capsulotomy, tenotomy, osteotomy, arthroplasty, arthrodesis, and sympathetic ganglionectomy and trunk resection. All have their place in the surgical reconstructive program for restoration of function in the arthritically disabled individual.—*Ruth Jackson M.D., Dallas, Texas.*

The Cure of Infantile Rickets with Tungsten-Filament Radiation. Henry J. Gerstenberger and Arthur J. Horesh. *J. Am. Med. Assn.* XCVII 766, Sept. 12, 1931.

The possibilities of "dual-purpose lighting" have been tested by the authors and found promising. Twelve-hour exposures to suberythemal doses of tungsten-filament radiation, produced by a 500-watt CX Mazda lamp suspended in oxidized aluminum reflectors from the ceiling of a room at a distance of five and one-half feet above the bed level, were given to two colored and one white moderately severe rachitic infants, over a period of ninety days, resulting in a complete cure as shown by blood and roentgen examinations.

The infants were dressed in shirt, diaper, and booties; goggles were not necessary. A definite pigmentation gradually developed over the exposed areas. Infections of the upper respiratory tract, which were present when the observations were begun, were not prevented from recurring, although they seemed to have become less severe.

The results of these observations indicate that "dual-purpose lighting", as proposed by Luckiesh probably will become practically feasible.—*Ruth Jackson, M.D., Dallas, Texas.*

Results of Treatment of Thrombo-angiitis Obliterans by Foreign Protein. Nelson W. Barker. *J. Am. Med. Assn.*, XCVII, 841, Sept. 19, 1931.

The results of 150 cases of thrombo-angiitis obliterans, treated by intravenous injections of foreign protein in the form of typhoid vaccines, lead the author to conclude that such treatment is valuable chiefly to carry a patient through one of the critical periods of exacerbation, provided gangrene has not already become too extensive. Once he has been carried through such a period, other measures should be substituted,—such as, education regarding the disease; protection of the extremities from mechanical,thermol, and chemical injury; special hygiene of the feet; limited activity; abstinence from tobacco; postural exercises; contrast baths; and, in certain selected cases, sympathetic ganglionectomy. The best results were secured in cases in which there was rest pain, with or without ulcers or limited gangrene.—*Ruth Jackson, M.D., Dallas, Texas.*

EXPERIENCES WITH PERIARTERIAL SYMPATHECTOMY IN FRACTURES OF THE LOWER EXTREMITY. Ralph Colp and Sigmund Mage. *J. Am. Med. Assn.*, XCVII, 1069, Oct. 10, 1931.

The belief that one of the greatest practical problems in industry is the speedy rehabilitation and economic restoration of the injured led the authors to perform periarterial sympathectomies on a group of patients having fractures of the lower extremities. In a series of seven recent fractures of the lower extremity, this operation resulted in an average diminution of eleven days in obtaining clinical union, of nineteen days in hospitalization, and no case showed a tendency toward delayed union. In a series of ten cases of delayed union in fractures of the lower extremity which were united after an average of seventy days, clinical union resulted twenty-one days after sympathectomy.

The authors feel that these results justify a further trial of this operation in recent fractures and in those in which union appears to be delayed.—*Ruth Jackson, M.D., Dallas, Texas.*

LA RÉSECTION ARTHROPLASTIQUE DE LA HANCHE (Arthroplastic Resection of the Hip). Paul Mathieu. *J. de Chir.*, XXXVIII, 1, July 1931.

The author recommends the reconstruction operation of Whitman for ununited fractures of the neck of the femur, old arthritis of the hip, traumatic or pathological dislocations which are not reducible, and ankylosis of the hip following arthritis or adolescent coxa vara. He describes the technique in detail.

The incision recommended is an anterior incision, extending from the anterior superior spine downward about twelve centimeters, and the lower angle of the incision is extended directly backward to beyond the posterior border of the iliotibial band. The anterior incision is carried downward between the sartorius and the tensor fascia lata. This gives a flap which, when folded upward and backward, exposes the great trochanter and the anterior surface of the hip joint. He recommends making a wide incision into the capsule of the hip and recommends cutting the head from the neck, either with a Gigli saw or a curved osteotome, before the head is removed, as violent manipulations necessary to exarticulate the head may throw the patient into profound shock.

The paper is unusually well illustrated and every detail of the operation for arthroplastic resection is clearly shown. A case of pseudarthrosis through the neck of the femur and a case of osteoarthritis are reported in detail and the results in each were good.—*J. Albert Key, M.D., St. Louis, Missouri.*

L'ARTHROTOMIE DE LA HANCHE PAR LE PROCÉDÉ D'OLLIER MODIFIÉ (Arthrotomy of the Hip by the Modification of Ollier's Method). J. Gatellier et Merle D'Aubigné. *J. de Chir.*, XXXVIII, 24, July 1931.

Ollier's incision is a curved lateral incision which is convex downward, the lower border of the incision being slightly below the level of the great trochanter. The trochanter is sectioned and folded upward, thus exposing the top of the hip joint. The authors have modified this incision by making it considerably larger, beginning at the anterior limb in the vicinity of the anterior superior spine and curving backward and downward to a point about two inches below the tip of the trochanter and upward and backward for a distance approximately equal to the length of the anterior incision. The dissection of the anterior limb is carried down between the tensor fascia lata and gluteus medius and the posterior limb is carried down between the gluteus medius and maximus. These two incisions are then further deepened and the capsule of the hip joint is opened in line with the skin incisions in front and behind. A Gigli saw is now introduced into the capsule and the trochanter is cut very obliquely, leaving the upper portion of the capsule attached to the trochanter. The muscles attached to the trochanter and upper portion of the capsule are retracted upward, giving wide exposure not only to the top of the hip joint, but also to the anterior and posterior surfaces. In operating for fracture of the neck of the femur, the authors place a bone peg through the stump of the neck, the peg entering at a point from which the trochanter has been removed and passing obliquely

downward through the neck to enter the head. The incision is closed in layers, the capsule being sutured and the trochanter being reattached by means of a screw. They recommend the incision for fractures of the neck of the femur, reconstruction operations, and arthroplasties and state that in their experience the operation is practically devoid of shock.—*J. Albert Key, M.D., St. Louis, Missouri.*

Traitement Chirurgical Immédiat des Entorses Graves du Genou (Immediate Surgical Treatment in Severe Sprains of the Knee). P. Oudard. *J. de Chir.*, XXXVIII, 321, Sept. 1931.

The author reports four personal cases and three cases from the literature in which severe injuries to the knee, with tearing of the lateral ligaments and with or without injuries to the crucial ligaments and semilunar cartilages, have been treated by immediate operation with suture of the torn lateral ligaments. It is his opinion that immediate surgery in these cases gives much better results than does conservative treatment, because he feels that it is asking too much to expect large ligaments like the lateral ligaments of the knee to heal by simple immobilization. The end results in the cases reported are unusually good for the type of injury under consideration.—*J. Albert Key, M.D., St. Louis, Missouri.*

Du Traitement de la Luxation Récidivante de l'Épaule par l'Opération de Oudard Modifiée (Treatment of Recurrent Luxation of the Shoulder by a Modification of the Operation of Oudard). Jazques-Charles Bloch et Olivier Guihéneuc. *J. de Chir.*, XXXVIII, 333, Sept. 1931.

The principle of Oudard's operation is a lengthening of the coracoid process so that it extends anteriorly and prevents the head of the humerus from slipping forward. In the authors' operation the patient is placed in a position with the arm abducted ninety degrees and an incision between the deltoid and pectoralis major muscles is carried down to expose the coracoid. This is then sectioned very obliquely from above downward and backward. The section of the process is performed by means of a series of small drill holes and the remaining bone is then cut with a thin osteotome. The tip and lower portion of the process is then slid forward about four centimeters, where it is tied to the base with circular silk ligatures or wire.

The authors report fifteen cases by Oudard and four of their own, none of which have any recurrence. This is an operation with which American surgeons are unfamiliar, but one which seems to be worth considering.—*J. Albert Key, M.D., St. Louis, Missouri.*

The Treatment of Tuberculous Joints with Cyanid of Gold. M. Friedland. *J. Sovremmennoi Chir.*, VI, 329, 1931.

Since 1925 the author has applied the above preparation in the form of injections into the diseased areas of bone tuberculosis. In order to obtain a relatively perfect local effect from the gold preparation, he applies a Bier's compression bandage, which insures a bloodless area and prevents the disintegrating action of the blood on the cyanid of gold.

In this bloodless area surrounding the tuberculosis focus he injects subperiostially a 1:1000 solution of aurum kali cyanatum with a fifty per cent. solution of novocain. The dose varies from 0.003 to 0.05 cubic centimeters in children to 0.01 to 0.2 in adults. In children he at times applies a general anaesthesia and omits the local novocain. The Esmarch tube and the elastic bandage are left on for about fifteen minutes after the injection.

At the beginning there is noticeable an increase of the inflammatory process. This subsides in a few days. The injections are repeated once or twice, giving all together not more than three injections at one-week intervals. This method has been used by the author on about fifty patients from four to thirty years of age. He has obtained eighty-four per cent. permanent results.

He attributes this favorable effect to the influence of gold cyanid on the tubercle bacilli, as well as to the general reaction upon the constitution. However, this method should only be regarded as an adjunct to other methods of treatment; it aids in shortening the time of recovery.—*A. Gottlieb, M.D., Los Angeles, California.*

A Case of Impending Volkmann's Ischaemic Contracture Treated by Incision of the Deep Fascia. C. W. Flemming. *Lancet*, II, 293, Aug. 8, 1931.

Treatment of this condition by incision of the deep fascia is now a well established procedure, but instances of the operation are rather scant in the literature. A case is described of a boy, aged ten, who sustained a supracondylar fracture of the left humerus. Five hours after the accident there was considerable swelling about the elbow; the radial pulse was easily felt. Forty-eight hours after the accident there was no pulsation at the wrist.

A longitudinal incison was made in the middle line over the antecubital fossa. The subcutaneous tissues were infiltrated with blood. When incised, the deep fascia split apart about three-fourths inch, and the muscles bulged into the gap. The muscle bellies were very pale, but there was no infiltration of blood into them. The wound was left open, and the arm put on a pillow. Next day, the radial pulse was still impalpable and there was pain in the forearm, but there was a full range of the fingers and wrist.

Nine months after the accident the range of movement at the elbow was ninety degrees' flexion and full extension; there was no limitation of pronation or of supination, and no pain.—*A. Gibson, M.D., Winnipeg, Canada.*

Observations on the Production of Antipoliomyelitis Serum in Horses and the Distribution of the Antibody among the Serum Fractions. R. W. Fairbrother and W. J. T. Morgan. *Lancet*, II, 584, Sept. 12, 1931.

An antiviral serum of marked activity against the poliomyelitis virus has been produced by the intramuscular inoculation of two horses with the living virus. Two other animals completely failed to respond.

It is well known that the variable nature of the disease makes it difficult to assess the value of specific forms of treatment in the prevention of paralysis, and it is generally believed that specific treatment with convalescent serum is likely to be of small value when given after the paralysis has appeared. It may be expected, however, that the renewed interest aroused by the production of antiviral serum in large animals may lead to much needed information on these debated points—*A. Gibson, M.D., Winnipeg, Canada.*

Transplantation of Bone. W. E. Gallie. *Lancet*, II, 687, Sept. 26, 1931.

Among the causes of failure, infection is the most frequent. A bone transplant ultimately dies and undergoes absorption in its bed. Success in bone grafting depends on (1) primary union, (2) firm healing of graft to bed, (3) final union of fragments to one another. The commonest defect is in not securing contact of graft to bed over a sufficient area; in radius or ulna, a graft should be embedded one and one-half inches into each fragment; in the tibia, two and one-half inches at each end. Another common error is insufficiently close contact between the graft and its bed; even a gap of one-eighth of an inch would cause non-union. Immobilization is of even greater importance in a graft than in a simple fracture. The graft must be placed in a vascular bed, and accordingly the sclerosed ends of the fragments are unsatisfactory, and should be removed. Mere removal of these ends is not enough. Adequate incision is essential; the periosteum should not be stripped more than necessary. For slender bones the diamond graft is suitable; the intramedullary peg is usually unsatisfactory. A graft of the whole fibula for the femur does not have this drawback as its own medullary cavity is available for the migration of osteogenetic tissue. For the tibia, the inlay-graft is best. The graft itself must contain living elements, be strong enough to act as a tem-

porary splint, and resist disintegration until sufficient new bone has been laid down to prevent its collapse. In the mandible the rib graft gives good results. Shortening of a bone was strongly recommended so as to get end-to-end union rather than an attempt to bridge a wide gap. When bridging was unavoidable, a diamond graft was used surrounded by multiple slivers and crushed cancellous bone.—*A. Gibson, M.D., Winnipeg, Canada.*

On the Apparent Diminution in Skeletal Muscle Tonus Following Removal of the Lumbar Sympathetic Trunk. Gilbert Phillips. *Med. J. of Australia*, I, 628, May 23, 1931.

The physiology of muscle tonus is reviewed and theories from those of Galen to the presen -day physiologists are critically discussed.

In connection with the fact demonstrated by Sherrington, that the myotonic or stretch reaction of posture-maintaining muscles is dependent upon a proprioceptive reflex, the question has now arisen: "Do the postganglionic fibers of the sympathetic nervous system constitute the efferent limb of the reflex arc subserving tonus in skeletal muscle?"

Royle and Hunter believed that they did.

In the present investigation fifteen cases were used. In all, the left lumbar sympathetic tract was removed. In eight, decerebration was done at once, and in seven decerebration was done after an interval of three weeks.

In each animal the knee extensor was isolated from extraneous proprioceptive and exteroceptive reflex effects by section of all cutaneous nerves to both hind limbs, and tenotomy or motor nerve section of all the muscles in both hind limbs with exception of the vasticrurei and that branch of the femoral nerve by which they are innervated.

The posture and postural reflex actions were then examined. The results obtained are detailed and from them it is concluded that sympathetic nerves are not responsible for the maintenance of posture in skeletal muscles, since decerebrate rigidity develops and is maintained and postural reflex activity is present in a muscle deprived of its sympathetic innervation; and, secondly, that the excitability of proprioceptive reflex-activity is increased in a postural muscle after removal of the sympathetic nerves distributed to it.

It is suggested that the apparent diminution of tonus, or decreased resistance to a passive stretching force, following removal of the sympathetic innervation to a postural muscle, is due to an increased excitability of the nerve endings whose stimulation produces the lengthening reaction in the muscle. This increased excitability is due to vascular disturbance.

The conclusion is that the postganglionic fibers of the sympathetic nervous system do not constitute the efferent limb of the reflex arc subserving posture in skeletal muscle.—*Edward N. Reed, M.D., Santa Monica, California.*

Fracture of the Os Calcis by Muscle Action. Henry Milch. *Med. J. and Record*, CXXXIV, 327, 1931.

The author reports a case with fracture of the os calcis by muscle action in a man, aged forty-seven, chronically ill. He was subject to depressive fits following an attack of encephalitis three years previously. During one of these fits the patient fell down half a flight of stairs, and was unable to walk unassisted upstairs. Swelling and ecchymosis soon developed about the right ankle and heel. He was able to get out of bed at the end of six weeks, but on walking complained of pain in the heel and of a limp.

The height of the right heel was markedly increased and appeared to consist of two prominences separated by a slight furrow. On the apex of the upper prominence there was a small encrusted scab, a dirty gray ulcer. There was no apparent limitation of motion at the tibiotarsal or subastragaloid joints. Roentgenograms showed a transverse fracture of the posterior portion of the os calcis.

The mechanism of the fracture in this case was a result of several factors. With the anterior portion of the os calcis fixed by the body weight, the posterior portion was subjected to the distracting force of the Achilles tendon pulling upward and the immobilizing action of the intrinsic foot muscles tending to pull downward on the tuberosities of the calcaneum. The other factor was the diminished tensile strength of the bone as a result of arterial changes and lack of activity.—*Robert Zollinger, M.D., Cleveland, Ohio.*

A Mixed Form of Chronic Arthritis. Benjamin H. Archer. *Med. J. and Record,* CXXXIV, 344, 1931.

In a series of 1,459 cases of chronic arthritis the author found about fifty-three per cent. belonged to the chronic infectious group and twenty-five per cent. were cases of arthritis of the menopause. The object of the study was to determine whether the proliferative and degenerative lesions of chronic arthritis arose simultaneously as part of the same pathological condition, or whether one form of the disease was superimposed upon the other as two pathological entities. He found a mixed form of chronic arthritis characterized clinically by the presence of grating knee joints, Heberden's nodes, and fusiform fingers in approximately one per cent. of the 1,459 cases. The mixed form of chronic joint disease presented the typical pathological lesions of proliferative and degenerative arthritis in the same patient. The proliferative lesions appeared less virulent and progressive than in younger people. The degenerative lesions were similar to those present in the arthritis of the menopause. This form of arthritis appeared to be a combination of an inflammatory and a degenerative process.—*Robert Zollinger, M.D., Cleveland, Ohio.*

New Method of Employing Skeletal Traction. Roger Anderson. *Northwest Med.,* XXX, 444, Oct. 1931.

The author presents an original design of skeletal traction apparatus utilizing the sound leg as a means of traction. It consists of a stirrup-like splint which is incorporated in a cast enclosing the sound limb. A lateral extension carries an adjustable lever, one end of which is attached to the skeletal traction on the injured member. The sound leg therefore acts as an extension splint, and by means of the adjustable lever considerable variations of its length are obtained. The advantages claimed are its simplicity, making it appliable in bed under local anaesthesia and saving the surgeon's time. It cannot get out of order and the patient may sit up the day it is applied. He finds himself more comfortable and the hospital period is lessened.

The author has reduced fractures of the symphysis pubis, femoral neck, shaft of the femur, and the leg bones, and presents x-ray evidence in support of its effectiveness.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

Intra-extra-articular Arthrodesis of the Hip Joint. V. D. Tchaklin. *Orthopaedia i Travmatologia,* I, 36, 1931.

The ordinary intra-articular arthrodesis in advanced cases of poliomyelitis does not produce always a firm ankylosis with good stability and absence of pain. The author devised a modification of the intra-articular operation and considers it successful in three cases operated upon by him. A curved Murphy incision is made over the hip joint. The glutei muscles are separated from the major trochanter. The trochanter is then osteotomized obliquely from the base upward and inward through the neck to the diaphysis. The joint is opened and the usual intra-articular arthrodesis is performed. Right above the acetabulum a small trough is made in the bone, the osteotomized part of the trochanter is turned 180 degrees, then moved into the trough and sewed with silk to the ilium and femur. The extremity is then held in ten to twenty degrees of abduction and twenty to thirty degrees of flexion for two months.—*Emanuel Kaplan, M.D., New York, N. Y.*

Changes in Bone Growth Under the Influence of Bone Tuberculosis. S. L. Tregubow. *Orthopaedia i Traumatologia*, II, 5, 1931.

Whenever a focus of lues, osteomyelitis, hemophilia and, particularly, of tuberculosis is located in the proximity of the epiphyseal line, a derangement of the bone growth is noticed; a lengthening of the diaphyses is observed, there is also an enlargement of the epiphyses accompanied frequently by an early maturity of the bone. These changes have been noticed in all the bones of the upper and lower extremities, also in the bones of the pelvis and are possible wherever the epiphyseal cartilage is still present. If the infection involves the epiphyseal line, the described changes do not occur. The explanation of this phenomenon lies in the irritation of the cartilage of the epiphyseal line, reflex manifestations, and possibly in some endocrine mechanism.—*Emanuel Kaplan, M.D., New York, N. Y.*

Operative Treatment of Acquired Radial Club-hand. G. A. Ilin. *Orthopaedia i Traumatologia*, II, 51, 1931.

The author reviews different methods of operation, as described by various surgeons. In cases where the distal fragment of the radius is preserved, the author recommends his procedure which results in a fair range of motion, excluding pronation and supination of the forearm. The steps of the operation are: Incision over the medial side of the lower third of the ulna. The ulna is divided six centimeters above the distal end, the proximal end of the ulna is then shaped into a sharp point. The remaining distal fragment of the radius is brought out into the wound and reshaped. The sharpened proximal end of the ulna is then introduced into the distal fragment of the radius. The forearm is fixed in neutral position in a plaster-of-Paris circular bandage.

Two cases were thus operated upon by the author with satisfactory results.—*Emanuel Kaplan, M.D., New York, N. Y.*

Volume III, 1931, of the *Orthopaedia i Traumatologia* contains a complete bibliography of the Russian orthopaedic literature for 1928.—*Emanuel Kaplan, M.D., New York, N. Y.*

So Called Calcifying Subacromial Bursitis. John B. Carnett. *Radiology*, XVII, 505, Sept. 1931.

Codman, who in 1906 first described the condition which he called "Subacromial Bursitis", also was the first to point out that the calcareous deposit occurs not in the bursa but beneath it, in, on, or under the supraspinatous tendon.

The use of the terms subacromial and subdeltoid bursa are misleading. There is one bursa, lying for the most part between the acromion and head of the humerus. A small part extends under the deltoid, but the bursa is properly called the subacromial bursa. Its location makes it inaccessible for complete excision.

Calcareous deposits may occur in or under the supraspinatous tendon, but bear no constant relationship to symptomatology for they may be present without giving symptoms; a mild trauma may precipitate acute symptomatology. Strangely enough, the advent of an acute flare-up of a calcified lesion is often followed by absorption of the lime deposit.

The lesion may be due to an acute traumatic rupture of some of the fibers of the supraspinatous muscle, or to oft-repeated occupational traumata, pinching the tendon between the humeral head and the acromion process, or the acromiocoracoid ligament.

The acute pain at the onset lasts from one to three or four weeks and then may subside completely or persist indefinitely as a dull ache. The more severe the attack, the more likely is the deposit to undergo spontaneous absorption. Symptoms may persist for some months after disappearance of the deposit, and a deposit in a symptomless shoulder may develop characteristic symptoms months or years later. X-rays of both sides in cases of bursitis with unilateral symptomatology show deposits in twenty-five per cent. of the symptomless shoulders. Calcifying bursitis is rare before thirty and usually occurs after forty years of age.

Calcified deposits can be demonstrated only by roentgenograms taken with proper technique,—*viz.*, the central ray directed slightly caudad and laterally, ten degrees from the vertical in each direction. Two exposures are necessary; one with the arm rotated fully outward and one inward. It is easy to mistake these deposits for fractures of the greater tuberosity. Recent deposits are liquid, later becoming caseous and finally gritty. They are always sterile on culture.—*Edward N. Reed, M.D., Santa Monica, California.*

UNRECOGNIZED VERTEBRAL FRACTURE *vs.* KUMMELL'S DISEASE (Syndrome). Fredrick W. O'Brien. *Radiology*, XVII, 661, Oct. 1931.

In his original article, in 1891, Kummell called this symptom-complex "rarefying osteitis of the vertebra" and in 1921 "post traumatic disease of the vertebra". Caused always by trauma, it is characterized by severe pain shortly after the accident, which gradually disappears, to appear after months or even years, together with symptoms of peripheral nerve involvement and a definite kyphos and gibbus.

He rules out fractures because of the slight trauma which often produced the condition, and the short duration of the original pain; but admits that a similar condition may result from impacted compression fracture. He believes that a vertebral body is elastic and can be compressed up to a certain point, without demonstrable fracture, and with complete restoration of its original size. This compression, however, does cause a "disorganization of the delicate framework of the bone and produce extravasation of blood in it", which is followed by a gradual disappearance of the bony framework.

Repair in fracture of a vertebral body is notoriously slow; non-union, with absorption and rarefaction, is frequent. This is probably because of the poverty of blood supply to vertebrae.

A wedge-shaped vertebra may occur without trauma,—as an extra segment. a half vertebra, which is wedge-shaped; or as a result of postural fault; or as a result of osteochondritis or epiphysitis (in which condition the base of the wedge may be either anterior or posterior).

The larger part of Kummell's observations were made before the development of satisfactory roentgenograms. With present x-ray technique a compression fracture can usually be demonstrated in these cases immediately following the trauma.

The author believes that the condition described by Kummell is really fracture of the spine,—unrecognized because of the absence of cord symptoms and of inadequate roentgen examination.—*Edward N. Reed, M.D., Santa Monica, California.*

TRAUMATIC LUXATION OF THE COCCYX. Carl S. Oakman. *Radiology*, XVII, 727, Oct. 1931.

There is little medical literature upon the radiographic aspects of fractures and luxations of the coccyx. Its various segments often become fused and, especially after middle age, the first segment may fuse to the sacrum. Variations from the normal curve are common, but apparently have little connection with symptomatology, and the same thing is true of lateral deviations.

Of the cases of luxation reported in the literature practically none include roentgen evidence.

Lateral projections are absolutely necessary in the study of these lesions.

It may be difficult to differentiate between fracture and dislocation.

While at one time there was a fad for excision of the coccyx for painful conditions, the present feeling is that this operation is justified only in certain cases of injury, and in tuberculosis, caries, periostitis, etc.

The most frequent cause of coccygodynia is injury. Fracture and dislocation are probably more common than reports indicate, and minor displacements may result in subsequent synovitis in the sacrococcygeal joint, adhesions, periostitis, periarticular thickening, and irritation of sensory nerves. Lesions after injury have a poor chance to heal because of the difficulty of securing rest.—*Edward N. Reed, M.D., Santa Monica, California.*

NOUVELLE TECHNIQUE POUR L'OPÉRATION D'ALBEE DANS LE MAL DE POTT SOUS-OCCIPITAL. Ath. Contargyris. *Rev. d'Orthopédie*, XVII, 736, Nov. 1930.

The author describes his technique of placing the Albee bone graft in the upper cervical region for tuberculosis. An opening is first made in the occipital bone to receive the upper extremity of the graft, following which the bed of the graft is made by freshening the surface of the tip of the first cervical spinous process, division of the spinous process of the second for a few millimeters, division of the third somewhat more deeply and division of the fourth one centimeter from the tip. Care is taken to preserve the interspinous ligaments. The graft placed in this groove is firmly maintained in place. The author reports a good result by this method, with patient under observation two years after the operation.

TRAITEMENT DU PIED BOT VARUS ÉQUIN CONGÉNITAL APRÈS DEUS ANS (Treatment of Congenital Equinovarus Club-foot after Two Years of Age). André Trèves. *Rev. d'Orthopédie*, XVIII, 393, Sept. 1931.

The key to the treatment of congenital equinovarus is the correction of the deformity and the displacement of the astragalus. Its depression in front and the hypertrophy of the luxated portion of the trochlea control the equinus; the inward torsion of the neck and of the head, with the scaphoid placed on its internal border, determines the varus; the obliquity of the under portion of the astragalus aids in the supination.

It is necessary to attack the astragalus in the treatment of remodeling or correcting the ligamentous, tendinous, and osseous obstacles which resist the replacement, both by the position and form. The astragalus should be removed if it is definitely useless.

The different observers are not in accord in regard to the treatment of this deformity; the fundamental difference lies between the purely mechanical and the surgical tendency. The conservative (mechanical) treatment conserves the integrity, and, at the same time, is neither brutal nor dangerous. The operative indications are rare in the young child, and the correction should always be obtained with the minimum of surgery, delayed as late as possible, subcutaneous, and only auxiliary to the manual replacement.

During this period which ends, in general, at about the age of two years—sometimes a little earlier, sometimes a little later—this condition can be regarded as relatively correctable. Finally, the astragalus becomes irreducible and the bones of the external row of the tarsus—the calcaneum and particularly the cuboid—become misshapen and produce the condition of absolute irreducibility, the classic osseous club-foot.

Until seven or eight years of age, the cartilaginous shell of each of the bones of the tarsus is still thin; the club-foot is more cartilaginous than osseous. This is the favorable period for the erosion of the tarsus, which permits modeling of the cartilaginous portion to establish a hypercorrection without injury to the articulations. One should begin by extirpating the center of the astragalus, which may be sufficient, but it may be necessary to remove also a portion of the calcaneum and the cuboid. The erosion should be by open surgery, taking care during the period of replacement and in the remodeling of the foot to lower the trochlear surface of the astragalus to prevent its replacement ultimately in front of the tibia. In addition to this erosion, it may be necessary to excise a portion of the cartilaginous tissue of the external surface of the astragalus.

After the age of seven or eight years, the sacrifice of the bone becomes necessary. When the degree of motion of the tibiotarsal articulation is sufficient, the trochlea of the astragalus can be preserved. Double osteotomy—astragalocalcaneus in the vertical and calcaneo in the horizontal direction—appears to the author preferable to the arthrodeses. Often the astragalus, which is incorrectly articulated with the mortise plate and rigid, should be removed entirely. The calcaneum is replaced perpendicularly between the malleoli, and the calcaneotibial nearthrosis will be more mobile and better adapted to its function than the articulation which it replaces.

With the adult, one does what is necessary—the vertical and horizontal cuneiform resection and section of the plantar aponeurosis—but the osseous sacrifices must be considerably more than with the child. Two points appear definite to the author: the necessity of early treatment and, with the young child, the application of those surgical methods which are benign, and as little mutilating as possible.—*Jacques Calvé, M.D., Berck-Plage, France.*

LES OSTÉOPATHIES HYPERTROPHIANTES. Charles Lasserre. *Rev. d'Orthopédie*, XVIII, 457, Sept. 1931.

The author mentions the difficulty of classification to include under any grouping the proper cases. The pathology and the etiology are not yet thoroughly understood. He bases his classification on the clinical aspect, the progress of the development and the anatomical radiographical appearances of the lesion. He devotes a large part of his paper to a consideration of the "*osteopathie deformante progressive de Paget*" which, he states, is seen under two forms,—the generalized and the localized. This usually appears as a stationary stage and the disease often exists for twenty years before reaching the terminal stage. There is no evidence to indicate a direct hereditary influence, but rather a predisposition or a favorable soil for the development of this condition. It usually appears about the fiftieth year and the appearances have never been better described than in the original communication of Paget. There is frequently a preliminary painful stage, the conditions progressing by painful recurrences. There is seen then a marked increase in the size and the shape of the bones. Frequently the dilatation of the venous circulation and hyperhidrosis, combined with the symptoms, suggest the possibility that the trophic cerebral medullary centers may be the partial cause. Certain complications have a surgical interest,—such as fractures, etc. Sarcomatous degeneration appears in about five per cent. of the cases and not necessarily in those bones which show the greatest amount of bone change. There are usually three stages which can be distinguished: (1) change of structure; (2) change in form; (3) change in topography.

The histological examination shows that absorption by the osteoblasts is the first phenomenon known. The haversian canals are obliterated and usually the bone structure undergoes an aseptic necrosis. Vascular and cardiac lesions are not infrequent and the thyroid and suprarenal glands may be affected. The acute syphilitic treatment relieves the painful symptoms, but does not affect the development of the lesions. Often actinotherapy has a beneficial effect upon the bone and occasionally on the recalcification.

The paper also stresses "*Les Ostéopathies Hypertrophiantes Craniofaciales*", "*La Périostose Engainante Acromélique*", "*La Mélorhéostose d'André Léri ou Hyperostose en Coulee*".

ZUR BEHANDLUNG ISCHÄMISCHER MUSKELKONTRAKTUREN (Treatment of Ischaemic Muscle Contracture). G. Haberler. *Zentralbl. f. Chir.*, LVIII, 1774, 1931.

From his observations in three cases of ischaemic muscle contracture, the author advocates the following therapeutic measures: Mild cases in the early stages can be cured by application of heat, massage and exercises. Older and more severe cases are to be treated with a turnbuckle apparatus which should be effective in removing all deformity. A primary operative procedure before applying this method must be considered a technical error, as it causes irreparable damage. If the turnbuckle method fails, owing to trophic disturbance, this should be treated by performing a neurolysis. In cases in which all the muscles of one group are completely atrophied and function is lost after correction of deformity, the only available method of treatment is one consisting of tendon lengthening and tendon transplantation.—*R. J. Dittrich, M.D., Wichita, Kansas.*